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CROP DISEASE DETECTION & INTELLIGENT FERTILIZER RECOMMENDATION SYSTEM

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ABSTRACT

In agriculture, the impact of plant diseases and pests on crop yield and quality is significant. Identifying and managing these issues is crucial for sustainable agriculture. Digital image processing techniques have emerged as powerful tools in this regard, with recent advancements in deep learning surpassing traditional methods. This review delves into the application of deep learning technology for the identification of plant diseases and pests, a topic of growing interest among researchers. The review begins by defining the problem of plant diseases and pests detection and compares it with conventional detection methods. It highlights the substantial progress made in recent years, focusing on the superiority of deep learning over traditional techniques. The study categorizes recent research into three aspects based on network structure: classification network, detection network, and segmentation network. Each approach's strengths and limitations are meticulously summarized.

Furthermore, the review introduces commonly used datasets and conducts a comparative

analysis of the performance of existing studies. It provides valuable insights into the effectiveness of various deep learning methods in real-world scenarios. Building upon this analysis, the study identifies potential challenges in the practical application of plant diseases and pests detection based on deep learning. These challenges include issues related to dataset quality, model generalization, and real-time implementation. In addressing these challenges, the review proposes innovative solutions and research directions. These solutions encompass techniques for dataset augmentation, transfer learning, and domain adaptation to enhance model robustness. Additionally, the study suggests exploring interdisciplinary collaborations between agriculture experts and machine learning researchers to develop more holistic and domain-specific solutions.

Finally, the review offers a comprehensive analysis of the future trends in plant diseases and pests detection based on deep learning. It anticipates the integration of advanced technologies such as edge computing and IoT devices to enable real-time monitoring and decision-making. The review underscores the need for continuous research and development to bridge the gap between theoretical advancements and practical agricultural applications.

Keywords: Deep Learning, Convolutional Neural Network, Plant Diseases and Pests, Classification, Object Detection, Segmentation.

1. NTRODUCTION

General Introduction

Introduction to Crop Diseases Detection and Intelligent Fertilizer Recommendation System

Agriculture is the backbone of global food production, but it faces numerous challenges, particularly crop diseases and inefficient use of fertilizers. These problems not only reduce crop yield but also affect the overall sustainability of farming practices. Addressing these issues through innovative technology can lead to significant improvements in agricultural productivity, reduce resource wastage, and promote environmental sustainability.

Crop Diseases Detection: Crop diseases are one of the most critical challenges farmers face, as they can quickly spread and devastate entire fields, leading to significant financial losses. Traditional methods of disease detection often rely on manual inspection and expert judgment, which can be time-consuming and prone to errors. With the advent of advanced technologies like image processing, machine learning, and artificial intelligence (AI), automated systems can now detect diseases early and accurately. By using sensors, drones, and cameras to capture high-resolution images of crops, AI algorithms can analyze these images to identify symptoms of diseases. This allows for early intervention, reducing the spread of diseases, minimizing pesticide usage, and improving overall crop health.

Intelligent Fertilizer Recommendation System: The efficient use of fertilizers is crucial for ensuring that crops receive the necessary nutrients while minimizing environmental impact. Overuse or underuse of fertilizers can lead to poor crop growth, soil degradation, and water pollution. Intelligent fertilizer recommendation systems leverage data analytics, soil health monitoring, and crop-specific nutrient requirements to provide personalized fertilizer recommendations.

These systems take into account factors such as soil composition, weather conditions, and crop type, helping farmers apply the right amount of fertilizer at the right time. By integrating machine learning models, these systems continuously improve their accuracy, optimizing crop yield while conserving resources and minimizing environmental damage.

Together, crop disease detection and intelligent fertilizer recommendation systems represent a powerful combination of technologies that can revolutionize modern farming. By harnessing the power of data, AI, and real-time monitoring, these systems can help farmers make informed decisions, reduce losses, and improve the overall sustainability and productivity of agriculture.

Project Objectives

1. **Development of a Crop Disease Detection System**

   Build a system capable of identifying diseases in crops using advanced image recognition and machine learning techniques.

   Provide farmers with timely alerts and information for better disease management.

2. **Development of an Intelligent Fertilizer Recommendation System**

   Create a system that recommends the optimal type and quantity of fertilizer based on soil health, crop type, and environmental conditions.

   Ensure accurate, cost-effective, and eco-friendly solutions for fertilization.

3. **Integration of Both Systems for Holistic Farm Management**

   Combine the crop disease detection and fertilizer recommendation systems into a unified platform.

   Enable a comprehensive approach to managing farm resources and improving crop yields.

4. **Enhancement of Decision-Making and Resource Efficiency**

   Facilitate data-driven decisions for farmers through actionable insights and reports.

   Minimize resource wastage while maximizing productivity and sustainability.

5. **Data Collection and System Optimization**

   Continuously collect and analyze data on soil, weather, crops, and farmer inputs.

   Use this data to refine the system's algorithms for better accuracy and reliability over time.

Problem Statement

Agriculture is a crucial sector for food security and economic stability. However, crop health is often threatened by diseases that can lead to significant losses in yield and quality.

Farmers, especially in remote or underdeveloped areas, face challenges in identifying diseases accurately and promptly due to a lack of expertise and resources. In addition, they often lack access to tailored recommendations for fertilizers based on the specific needs of the soil and crops, which can lead to overuse or underuse of fertilizers, negatively impacting crop productivity and the environment.

2. SYSTEM PROPOSAL

Existing System

Crop disease detection and intelligent fertilizer recommendation systems integrate cutting-edge technologies to revolutionize agriculture. Machine Learning (ML) plays a key role in recognizing patterns in complex datasets, while Artificial Intelligence (AI) facilitates intelligent decision-making for effective problem-solving. Computer Vision enables image-based disease identification, enhancing accuracy in detecting crop ailments.

Internet of Things (IoT) devices gather real-time environmental and soil data, aiding in timely interventions. Geographic Information Systems (GIS) contribute to large-scale monitoring and mapping, improving precision in resource allocation. Big Data Analytics processes vast amounts of information to deliver accurate predictions and insights. Cloud Computing ensures scalability and remote access to data and tools, making these systems widely deployable. Natural Language Processing (NLP) enhances user interaction by enabling intuitive communication, and mobile applications bring these advanced capabilities directly to farmers, ensuring accessibility and ease of use. Collectively, these technologies optimize agricultural resources, reduce wastage, and significantly improve crop yield, paving the way for precision agriculture and sustainable farming practices.

Issues with existing system

1. High Initial Cost

- Advanced systems often require significant investment in IoT devices, high-resolution imaging equipment, cloud services, and computational infrastructure for Machine Learning and Big Data Analytics.
- For small-scale farmers, these upfront costs can be prohibitively expensive, making the technology inaccessible to a large segment of the agricultural community.
- Additionally, the cost of training and maintenance further adds to the financial burden.

2. Technical Complexity

- The integration of multiple advanced technologies such as ML, AI, IoT, and GIS results in complex systems that may require technical expertise for operation and troubleshooting.
- Farmers may lack the necessary skills to use these systems effectively, creating a barrier to adoption.
- Insufficient user training or poorly designed interfaces may further exacerbate usability challenges.

3. Data Dependency

- These systems rely heavily on large datasets for accurate predictions and recommendations, including historical crop, soil, and weather data.
- In regions with limited or incomplete data availability, the accuracy of the system's outputs may be compromised.
- Frequent data updates are required to maintain system relevance, which can be challenging in areas with inadequate data collection infrastructure.

4. Connectivity Issues

- Reliable internet connectivity is crucial for real-time data transmission between IoT devices, cloud servers, and user interfaces.
- Rural or remote farming areas often lack stable internet access, hindering the system's functionality.
- Interruptions in connectivity can delay critical interventions, reducing the system's effectiveness during emergencies.

5. Privacy Concerns

- The collection and transmission of sensitive data, including geolocation, farm-specific data, and user interactions, raise privacy issues.
- Farmers may be reluctant to adopt such systems due to fears of data misuse, unauthorized sharing, or lack of transparency in data handling policies.
- Ensuring robust data protection measures and compliance with privacy regulations is essential to building trust among users.

Proposed System

The proposed system aims to integrate advanced technologies to provide farmers with an efficient and user-friendly solution for crop disease detection and intelligent fertilizer recommendation. It leverages Machine Learning models to analyze crop images for accurate disease identification and Artificial Intelligence for personalized fertilizer recommendations based on real-time data. Internet of Things (IoT) devices collect environmental, soil, and crop-specific data, which is processed using Big Data Analytics to generate actionable insights. Geographic Information Systems (GIS) support large-scale monitoring, while Cloud Computing ensures scalability and accessibility. A mobile application serves as the primary interface, incorporating Natural Language Processing (NLP) for seamless interaction and multilingual support to cater to diverse farmer communities. By offering precise, data-driven recommendations and real-time monitoring capabilities, the system optimizes resource utilization, enhances crop health, and increases overall agricultural productivity.

Benefits of proposed system

1. Early Disease Detection

The system employs Machine Learning models to analyze crop images, enabling precise and early identification of crop diseases. This proactive approach helps farmers take timely action, preventing the spread of diseases and minimizing crop loss.

2. Intelligent Fertilizer Recommendation

Personalized fertilizer recommendations are generated using AI algorithms, tailored to real-time soil conditions, crop requirements, and environmental factors. This ensures optimal nutrient application, improving crop yields and reducing waste.

3. Increased Productivity

By addressing crop diseases early and optimizing resource utilization, the system enhances overall agricultural productivity. This leads to higher crop quality and quantity, contributing to food security.

4. Economic Benefits

Efficient resource utilization reduces unnecessary expenses on fertilizers, pesticides, and other inputs. Moreover, increased yields translate to higher profits for farmers, significantly boosting their economic well-being.

5. Accessibility and Scalability

The integration of Cloud Computing ensures that the system is accessible anytime and anywhere, even in remote areas. A mobile application with multilingual support and Natural Language Processing (NLP) makes the system user-friendly for diverse farmer communities. Additionally, the scalable architecture supports large-scale deployment and future technological advancements.

3. LITERATURE SURVEY

1. Plant Disease Detection using Machine Learning by Ms. Nilam Bhise, Ms. Shreya Kathet, Mast. SagarJaiswar, Prof. Amarja Adgaonkar at www.irjet.net

In the study titled **"Plant Disease Detection using Machine Learning,"** the authors address the critical issue of identifying and detecting diseases in plants, which significantly impact crop yield and agriculture. Traditional methods of disease detection, involving manual observation and laboratory tests, are time-consuming and often inaccurate. To overcome these challenges, the researchers employ image processing techniques, including image acquisition, extraction, segmentation, and preprocessing. They utilize a Convolutional Neural Network (CNN) to classify plant diseases based on images of leaves, stems, and fruits.

The proposed system integrates hardware components such as smartphones and Graphics Processing Units (GPUs) with software components like Android Studio, Keras, and TensorFlow Lite. The Android app developed in Kotlin captures plant images, which are then processed through CNN. The system's effectiveness relies on the careful preprocessing of images to enhance accuracy. The model's performance is validated through numerical arrays, feature extraction, and layer outputs, demonstrating its ability to classify diseases accurately.

The study emphasizes the importance of expanding the dataset to include more plant species and diseases, enhancing the system's accuracy. Additionally, future improvements include user contribution to the dataset and providing remedies for identified diseases. Overall, the research showcases the potential of machine learning, particularly CNN, in revolutionizing plant disease detection for sustainable agriculture.

2. Plant Disease Detection Using CNN by Nishant Shelar1 , Suraj Shinde2 , Shubham Sawant3 , Shreyash Dhumal4 , and Kausar Fakir at https://doi.org/10.1051/itmconf/20224403049

The provided text discusses a research paper titled **"Plant Disease Detection Using CNN"** authored by Nishant Shelar and colleagues. The paper focuses on the detection of plant diseases using Convolutional Neural Networks (CNNs). Plant diseases significantly impact agricultural production, and timely detection is crucial for preventing large-scale crop losses. The authors propose a Disease Recognition Model based on leaf image classification, utilizing image processing techniques and CNNs for accurate and efficient detection.

The paper begins by emphasizing the importance of agriculture and the challenges posed by plant diseases. It reviews related works in the field of plant disease detection, highlighting various techniques and technologies employed by researchers. The authors specifically mention the use of CNNs and deep learning methods in recent studies for accurate disease identification.

The proposed system involves collecting data from the PlantVillage Dataset, preprocessing and augmenting the dataset using Keras' Image-data generator API, and building a CNN model based on the VGG-19 architecture for classifying various plant diseases. The CNN architecture comprises convolutional layers, pooling layers, and fully connected layers. The authors successfully trained the model on 50 epochs, achieving a 95.6% accuracy rate using early stopping.

The paper includes visualizations depicting the training and validation accuracy of the model. Additionally, the authors present the results of detecting and recognizing diseases in strawberry and potato plants. The CNN model successfully identifies and classifies various plant diseases with high accuracy.

In conclusion, the research paper demonstrates the successful implementation of a CNN-based

plant disease detection system. The proposed approach shows promising results in accurately classifying diseases in different plant species. The authors also indicate ongoing efforts to improve the accuracy of the model and the associated Android application for real-time disease detection.

3. Plant Disease Detection Using Deep Learning by Kowshik B1,Savitha V2, Nimosh madhav M3,Karpagam G4, Sangeetha K5 at www.rspsciencehub.com

Agriculture plays a vital role in sustaining human life, with a significant portion of the global population engaged in agricultural activities. Crop diseases pose a threat to agricultural productivity, making early detection crucial. Traditional methods lack the efficiency needed for timely disease identification, hindering agricultural progress. The paper explores the application of Deep Learning (DL) techniques, specifically Convolutional Neural Networks (CNNs), to enhance the accuracy of plant disease detection.

The authors emphasize the importance of agriculture in India's economy and highlight challenges such as climate change, crop pests, and water shortages affecting food security. Early disease detection is essential to mitigate these challenges. The study proposes a methodology utilizing CNNs and Deep Neural Networks for effective and precise identification of crop disease symptoms. Various efficiency metrics are employed to evaluate the proposed models.

The paper addresses existing limitations in disease detection, such as slow and manual observation methods, and proposes an automated system. The authors introduce a multi-step process involving image acquisition, pre-processing, enhancement, segmentation, analysis, feature extraction, and disease classification. These steps leverage techniques like OpenCV and CNNs to enhance the accuracy and speed of disease identification. The research aims to create a cost-effective, open-source solution accessible to farmers.

In conclusion, the study presents a comprehensive approach to plant disease detection using DL techniques. The proposed system utilizes CNNs and DNNs to identify diseases in their early stages, enabling timely intervention. The research has the potential to significantly impact agricultural practices, ensuring better crop yields and food security. The authors suggest future enhancements, including integrating the system with additional features like market information and pesticide recommendations, enhancing its utility for farmers. The paper contributes to the advancement of automated plant disease detection, a critical aspect of modern agriculture.

4. Prediction Of crop Yield and fertilizer recommendation using ML by Devdatta A. Bondre Mr. Santosh Mahagaonkar at http://www.ijeast.com

The paper titled **"Prediction of Crop Yield and Fertilizer Recommendation Using Machine Learning Algorithms"** explores the application of machine learning techniques in agriculture, specifically focusing on crop yield prediction and fertilizer recommendation. The study utilizes algorithms like Support Vector Machine (SVM) and Random Forest (RF) for soil classification, crop yield prediction, and fertilizer recommendation. Here is a summary of the key points from the paper:

Introduction: The paper emphasizes the importance of accurate crop yield prediction in

modern agriculture. Traditional methods of prediction based on farmer's experience are being replaced by machine learning techniques due to their ability to analyze vast amounts of data for accurate predictions.

Proposed Work: The study proposes a three-step approach:

1. Soil Classification: Soil classification is performed using Random Forest and Support Vector Machine algorithms based on soil nutrient data. Random Forest achieved an accuracy of 86.35%, while SVM achieved 73.75%.
2. Crop Yield Prediction: Crop yield prediction is done using crop yield data, nutrients, and location data. SVM algorithm achieved an accuracy of 99.47%, while RF achieved 97.48%.
3. Fertilizer Recommendation: Fertilizer recommendation is made based on fertilizer data, crop, and location data. The system also provides weather information using third-party APIs.

Results:- Soil Classification: RF achieved an accuracy of 86.35%, and SVM achieved 73.75%.- Crop Yield Prediction: SVM achieved an accuracy of 99.47%, and RF achieved 97.48%.

- Fertilizer Recommendation: Suitable crops and required fertilizers for each crop are recommended. Conclusion and Future Scope:The study concludes that SVM is more accurate for crop yield prediction, while RF is better for soil classification. The system could be extended with features like image-based crop disease detection and smart irrigation systems.

5. Plant Leaf Disease Detection using Convolution Neural Network by Shreya Patil, Soukhya L Deshpande, Soumya Sumbad, Soumya S Kiranagi atwww.ijcrt.org

The paper titled **"Plant Leaf Disease Detection Using Convolution Neural Network"** addresses the crucial issue faced by farmers worldwide: the loss of crops due to pests, diseases, or nutrient deficiencies. Traditional methods of disease identification, such as visual inspection, are time- consuming and often inaccurate. To address this, the paper proposes a solution using Convolutional Neural Networks (CNNs) for accurate and rapid detection of plant leaf diseases.

Abstract:The paper introduces an approach to detect plant diseases using deep Convolutional Neural Networks (CNNs). The proposed system utilizes the MobileNet and VGG16 CNN models for accurate disease classification. By training the models on a dataset comprising various plant diseases, the system provides precise and rapid disease identification, thereby offering effective solutions to farmers. Introduction:The global demand for crop production is increasing, making it imperative to address issues such as pests and diseases promptly. Traditional human estimation methods are no longer feasible, leading to the development of computer vision models. CNNs have emerged as powerful tools for this task, offering standardized and rapid disease detection. The paper focuses on RGB data due to the complexity of diseases, which often exhibit measurable variations in color, shape, or function.

4. METHODOLOGY

Data Collection: The dataset comprises over 32,000 plant leaf images,

including healthy and diseased samples from various plant species.- Image Pre-processing: Data augmentation and annotation techniques are employed to enhance the dataset.- CNN Architecture: The CNN model includes Conv2D layers for convolution, Max Pooling layers for feature selection, and Flattening layers for data transformation. Training is conducted using epochs, ensuring the model learns from the dataset effectively.

- Training and Testing: The dataset is split into 70% for training and 30% for testing and validation. The model's performance is evaluated using various metrics.
- Results:- The proposed system successfully identifies diseases in plant leaves, displaying the
- disease names such as "Apple Scab" and "Apple Black Rot."
- Accuracy vs. Epochs graph demonstrates the model's learning progress over multiple epochs, indicating its efficiency in disease detection.

Conclusion: The paper concludes that accurate plant leaf disease detection is crucial for minimizing yield losses. The CNN-based approach presented in the paper offers an efficient and effective solution. By employing deep learning techniques, the system not only accurately identifies diseases but also suggests appropriate remedies.

Wheat Disease Detection using SVM Classifier by Er.Varinderjit Kaur , Dr.Ashish Oberoi at www.ijetir.org

The research paper explores the vital realm of agricultural technology, specifically focusing on the detection of wheat diseases using advanced computational methods. It begins by highlighting the immense significance of agriculture in addressing global challenges, such as food security and climate change. The authors emphasize the critical need for accurate disease diagnosis, as diseases can significantly impact crop yields, leading to economic losses.

The paper delves into the limitations of traditional disease detection methods, particularly the subjectivity and potential errors associated with human visual assessment. It underscores the transformative potential of digital image processing, which enables the precise analysis of plant health through detailed image data. The authors meticulously outline the intricate process of disease detection, starting with image acquisition using high-resolution cameras. They explain the importance of image preprocessing techniques, such as contrast enhancement and noise reduction, to ensure the quality of the input data. The segmentation process, which involves isolating the plant regions from the background, is discussed in detail. Various segmentation methods, including K-means clustering and Otsu segmentation, are explored for their effectiveness in delineating disease spots.

A significant portion of the paper is dedicated to feature extraction, where essential characteristics of the plant, such as color, shape, and texture, are quantified. These features serve as the basis for disease classification. The authors provide an in-depth analysis of different classification techniques, including Support Vector Machine (SVM) and Artificial Neural Networks (ANN), discussing their strengths and weaknesses in the context of disease detection.

A focal point of the paper is the application of SVM in wheat disease classification. The authors elucidate the complex process of SVM implementation, emphasizing the challenges encountered during training and classification.

They provide a detailed account of their experimental setup, including the dataset used and the evaluation metrics applied. Throughout the paper, the authors enrich their findings by referencing prior studies and methodologies, grounding their research in the existing body of knowledge. The paper not only presents a robust analysis of cutting-edge technologies in agriculture but also offers critical insights into the future potential of computational methods in revolutionizing disease detection and, consequently, agricultural productivity. Researchers, scientists, and agricultural experts are likely to find this comprehensive exploration immensely valuable in advancing their work in the field.

Plant Infection Detection Using Image Processing by 1Dr. Sridhathan C, 2Dr. M. Senthil Kumar at www.ijmer.com

The paper begins by highlighting the critical role of agriculture in a country's economic development and the challenges farmers face due to environmental conditions that can lead to crop infections. Traditional disease detection methods rely on visual observation, which can be time- consuming and requires a large expert team. The authors propose an automated plant infection monitoring system utilizing image processing techniques. Three types of plant diseases, Anthracnose, Cercospora Leaf Spot, and Bacterial Blight, are classified.

The section discusses the shift from traditional methods to image processing techniques in identifying plant infections. It outlines the steps involved in disease detection, emphasizing the importance of image enhancement and conversion to grayscale for easier processing. The paper mentions the use of K-means clustering for color segmentation and Gray-Level Co-occurrence Matrix (GLCM) for texture analysis.

This section details the steps involved in the proposed plant infection detection system. Images of infected leaves are captured using mobile phones or digital cameras. Image pre-processing techniques are applied to enhance image quality, followed by K-means segmentation to isolate infected areas. Feature extraction is performed using GLCM, and disease classification is based on texture information. The methodology is described through a block diagram and images illustrating the process.

The results of the automated detection system are presented, showing the classification of diseases (Anthracnose, Cercospora Leaf Spot, and Bacterial Blight) along with the affected area percentages for different leaf samples. The system achieves an accuracy of 98.27% in disease classification, demonstrating its effectiveness in identifying infections.

The paper concludes that the proposed image processing-based approach provides an efficient and accurate method for plant disease detection and classification. It reduces detection time and labor costs, enabling timely remedial actions for farmers. The authors plan to expand the database for more comprehensive leaf disease identification in future work.

8. Plant Disease Detection Using Machine Learning by Shima Ramesh, Mr. Ramachandra Hebbar, Niveditha M, Pooja R, Prasad Bhat N, Shashank N at: https://www.researchgate.net/publication

This paper addresses the challenge of identifying plant diseases, a significant threat to food security, especially in rural areas lacking proper infrastructure. The study employs machine learning techniques, specifically Random Forest, for distinguishing between healthy and diseased leaves based on leaf images. The methodology involves dataset creation, feature extraction using Histogram of Oriented Gradient (HOG), training the classifier, and classification. The RGB images are preprocessed and converted to grayscale, and features such as Hu moments, Haralick texture, and Color Histogram are extracted. Random Forests, known for their ability to handle both numeric and categorical data, are employed as the classification algorithm.

Plant diseases are a substantial threat to agriculture and food security. Traditional methods are often not cost-effective or timely. This paper focuses on leveraging machine learning, specifically Random Forests, for efficient disease detection. The objective is to identify plant diseases through image processing and machine learning techniques.

The paper discusses related works in the field, highlighting previous studies that utilized various methods such as neural networks, pattern recognition techniques, fuzzy logic, and SVM-based classifiers for plant disease detection. The comparison underscores the advantages of the proposed Random Forest approach. The methodology involves several steps, including preprocessing, feature extraction (using Hu moments, Haralick texture, and Color Histogram), and employing Random Forests as the classifier. The feature extraction is particularly focused on utilizing the HOG descriptor. The paper provides detailed flowcharts and explanations of the proposed algorithm's architecture and functioning. The Random Forests algorithm is chosen for its flexibility and ability to handle both numeric and categorical data. The paper explains the process of dataset splitting, feature extraction, and training and testing the classifier. The feature vectors extracted from training and testing datasets are fed into the trained classifier for prediction.

The paper presents results in the form of images and tables, showcasing the effectiveness of the proposed approach. Accuracy is compared with various machine learning models, where Random Forests outperform other methods with an accuracy rate of approximately 70%.The proposed algorithm demonstrates the potential for automating plant disease detection using machine learning techniques, particularly Random Forests. Despite achieving a 70% accuracy rate, the paper suggests that further improvements can be made by expanding the dataset and exploring additional local features in conjunction with global features.

9. Plant leaf disease detection using Convolution Neural Network. By Jun Liu and Xuewei Wang at https://doi.org

Plant diseases and pests pose significant threats to global food supply. Traditional manual methods of detecting these issues are time-consuming, error-prone, and often inadequate for early identification. Advanced technologies, particularly Machine Learning (ML) and Deep Learning (DL), offer promising solutions. ML algorithms like c4.5 classifier and tree bagger, and DL techniques such as Convolutional Neural Networks (CNNs) and Deep Belief Networks (DBNs), have been pivotal in transforming plant pathology. ML algorithms can recognize specific patterns and early symptoms of diseases from digital images. However, they require substantial annotated data, limiting their effectiveness for novel diseases. DL techniques, such as CNNs, excel in identifying subtle symptoms that traditional methods miss, but demand extensive labeled training data and computational resources, making them challenging for certain applications.

CV algorithms, encompassing object detection and semantic segmentation, enable the identification and localization of regions of interest in images, such as plant leaves and disease symptoms. Integrating CV with ML or DL algorithms enhances disease detection and classification. Nonetheless, these approaches require large labeled datasets, making them less suitable for previously unseen diseases. AI technologies, including ML, DL, and CV, have shown promise in identifying plant abnormalities and infestations. ML-based classification and lesion segmentation, DL's ability to identify subtle symptoms, and CV's potential for precise localization are transformative. However, the need for extensive annotated data and the challenge of detecting novel diseases remain significant limitations.

To advance plant disease detection, further research is crucial. Developing generalizable models applicable to diverse plant species and diseases is essential. Increasing the availability of publicly accessible datasets for training and evaluation purposes is imperative. While AI technologies have significantly improved the precision and speed of plant disease detection, ongoing research is vital to address the challenges and limitations posed by novel diseases and limited data availability.

In conclusion, the integration of AI technologies, including ML, DL, and CV, in plant disease detection signifies a transformative paradigm shift. Despite challenges, these advancements hold immense potential to revolutionize the field of plant pathology, paving the way for more accurate, efficient, and timely disease identification and management.

10. An advanced deep learning models-based plant disease detection at https://www.frontiersin.org/

This paper addresses the challenge of identifying plant diseases, a significant threat to food security, especially in rural areas lacking proper infrastructure. The study employs machine learning techniques, specifically Random Forest, for distinguishing between healthy and diseased leaves based on leaf images. The methodology involves dataset creation, feature extraction using Histogram of Oriented Gradient (HOG), training the classifier, and classification. The RGB images are preprocessed and converted to grayscale, and features such as Hu moments, Haralick texture, and Color Histogram are extracted. Random Forests, known for their ability to handle both numeric and categorical data, are employed as the classification algorithm. Plant diseases are a substantial threat to agriculture and food security. Traditional methods are often not cost-effective or timely. This paper focuses on leveraging machine learning, specifically Random Forests, for efficient disease detection. The objective is to identify plant diseases through image processing and machine learning techniques.

The paper discusses related works in the field, highlighting previous studies that utilized various methods such as neural networks, pattern recognition techniques, fuzzy logic, and SVM-based classifiers for plant disease detection. The comparison underscores the advantages of the proposed Random Forest approach. The methodology involves several steps, including preprocessing, feature extraction (using Hu moments, Haralick texture, and Color Histogram), and employing Random Forests as the classifier. The feature extraction is particularly focused on utilizing the HOG descriptor. The paper provides detailed flowcharts and explanations of the proposed algorithm's architecture and functioning. The Random Forests algorithm is chosen for its flexibility and ability to handle both numeric and categorical data. The paper explains the process of dataset splitting, feature extraction, and training and testing the classifier. The feature vectors extracted from training and testing datasets are fed into the trained classifier for prediction. The paper presents results in the form of images and tables, showcasing the effectiveness of the proposed approach. Accuracy is compared with various machine learning models, where Random Forests outperform other methods with an accuracy rate of approximately 70%.The proposed algorithm demonstrates the potential for automating plant disease detection using machine learning techniques, particularly Random Forests. Despite achieving a 70% accuracy rate, the paper suggests that further improvements can be made by expanding the dataset and exploring additional local features in conjunction with global features.

Gap Analysis

Paper Name	Algorithm used	location-based alerts	Fertilizer Rrecommendation	Disease Detection
Plant Disease Detection using Machine Learning	CNN (convolutional neural network)	NO	NO	YES
Plant Disease Detection	CNN (convolutional neural network)	NO	NO	YES
Plant Disease Detection Using Deep Learning	Deep Learning CNN,DNN	NO	NO	YES
Prediction Of crop Yield and fertilizer recommendation	SVM Random Forest	NO	YES	YES
Plant leaf disease detection using Convolution Neural Network.	MobileNet model,VGG16, a type of CNN	NO	gives the remedies for the diseases.	YES
Wheat disease detection using SVM classifier.	SVM, PCA	NO	NO	YES

Paper Name	Algorithm used	location-based alerts	Fertilizer Rrecommendation	Disease Detection
Plant Infection Detection Using Image Processing	K- Mean Segmentation, GLCM,	NO	NO	YES
Plant Disease Detection Using Machine Learning	Random forest	NO	NO	YES
Plant leaf disease detection using Convolution Neural Network.	Deep learning, Convolutional neural network	NO	YES	YES
An advanced deep learning models-based plant disease detection	Image Processing CNN	NO	YES	YES

5. SYSTEM DIAGRAMS

5.1 ARCHITECTURE DIAGRAM

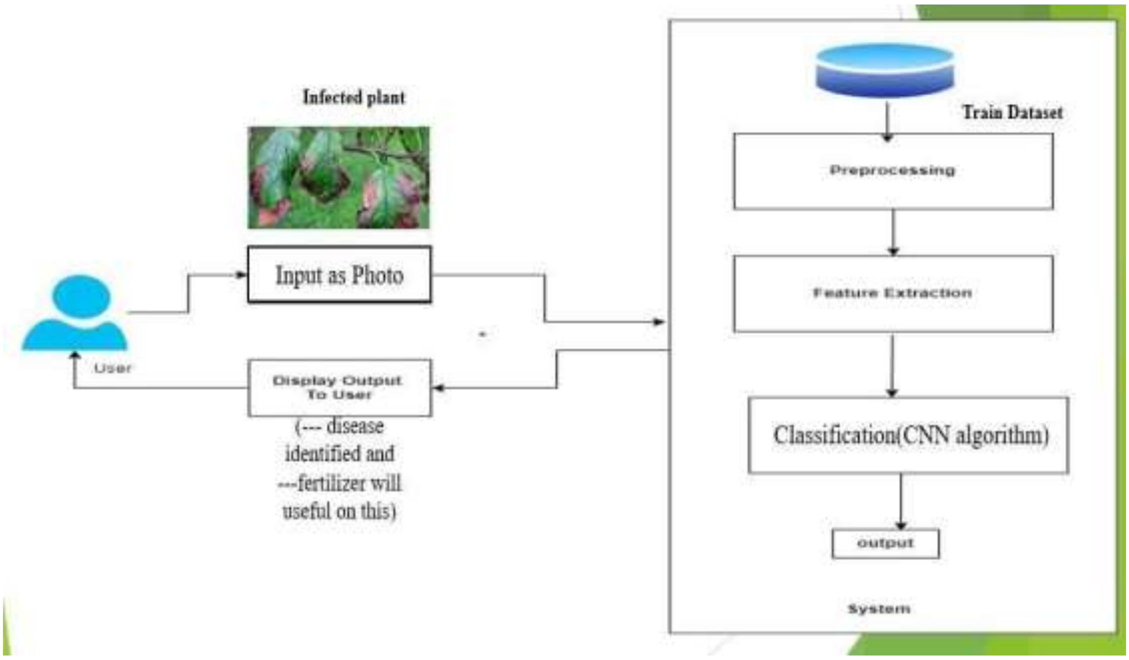

Figure 5.1. System Architecture

5.2 Data Flow Diagram:

In Data Flow Diagram, we Show that flow of data in our system in DFD0 we show that base DFD in which rectangle present input as well as output and circle show our system, In DFD1 we show actual input and actual output of system input of our system is text or image and output is rumor detected like wise in DFD 2 we present operation of user as well as admin.

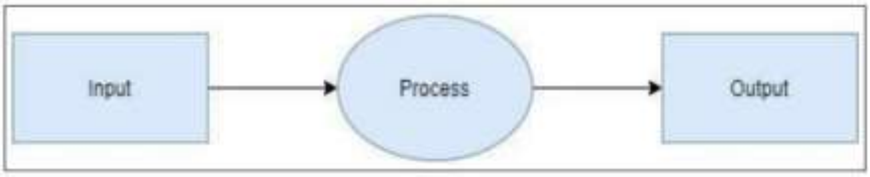

Figure 5.2 - DFD LEVEL 0 DIAGRAM

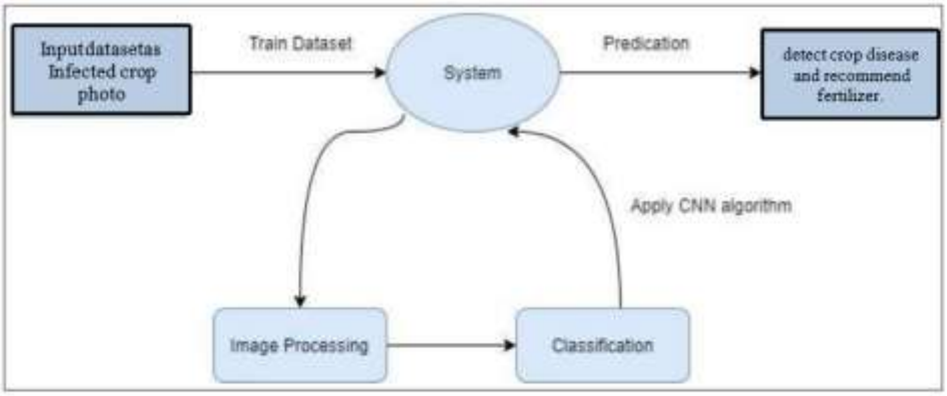

Figure 5.3. DFD LEVEL

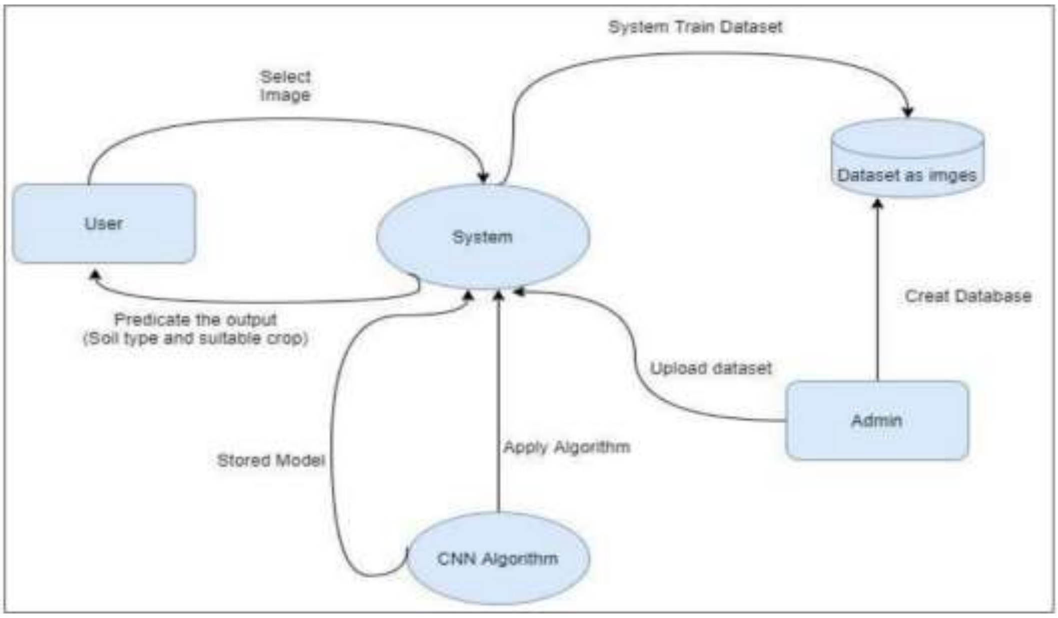

Figure 5.4 :- DFD LEVEL 2

5.3 Entity Relationship Diagrams :

Explanation: Entities:

- User: Represents users of the web application. It contains attributes like UserID, Name, Email, and Location.
- UploadedPhoto: Represents the photos uploaded by users. It contains attributes like PhotoID, PhotoURL, and UploadDate.
- DetectedDisease: Represents the diseases detected by the CNN model. It contains attributes like DiseaseID, DiseaseName, and ConfidenceLevel.
- FertilizerRecommendation: Represents the recommended fertilizers. It contains attributes like RecommendationID, FertilizerType, and ApplicationMethod.
- Relationships:

- Uploads: Represents the relationship between users and uploaded photos. A user can upload multiple photos.
- Detects: Represents the relationship between uploaded photos and detected diseases. Each uploaded photo can be associated with multiple detected diseases.
- Recommends: Represents the relationship between detected diseases and fertilizer recommendations. Each disease can have multiple recommended fertilizers.
- Receives: Represents the relationship between users and fertilizer recommendations. Each user can receive multiple fertilizer recommendations.
- Collaborates: Represents a collaborative relationship between users. This could be used for location-based alerts or community collaboration.

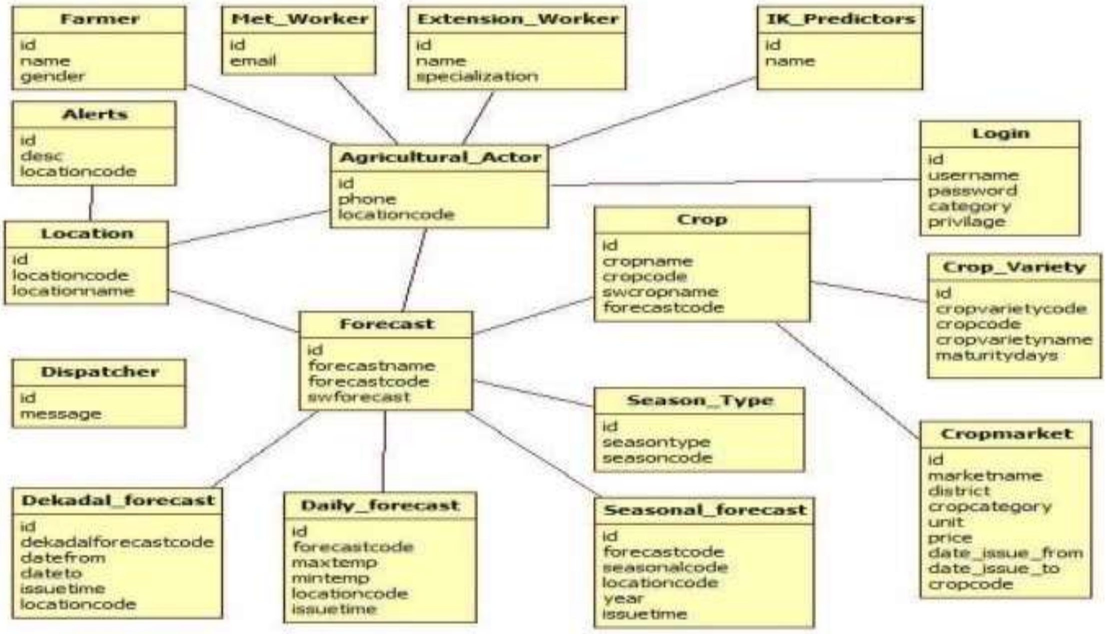

Figure 5.5 :-Entity Relationship

5.4 Use Case Daigram :

 Class Diagram Explanation:

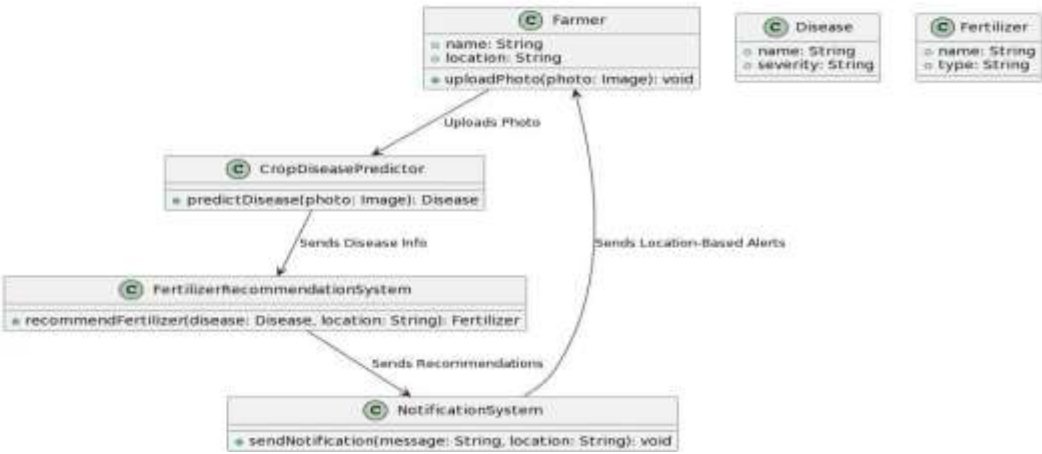

Figure 5.6. Class Diagram

- Farmer : Represents individual farmers using the application. They can upload photos, which trigger disease prediction.
- Crop Disease Predictor : Class responsible for predicting crop diseases based on the uploaded photos.
- Fertilizer Recommendation System : Recommends suitable fertilizers based on the identified disease and location.
- Notification System : Sends notifications and alerts to farmers based on their locations.
- Disease : Represents the type and severity of the detected disease.
- Fertilizer : Represents the recommended fertilizer's name and type.

Component Diagram Explanation :

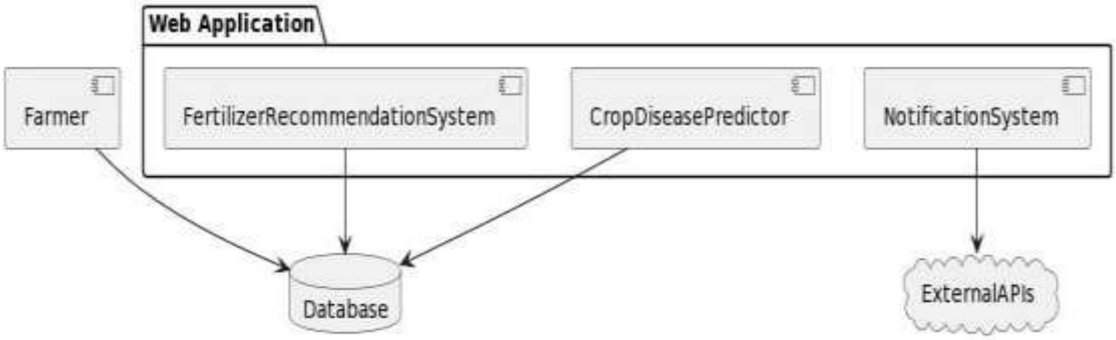

Figure 5.7. Component Diagram

- Web Application Package : Contains components responsible for disease prediction, fertilizer recommendation, and notifications.
- Database : Represents the storage system for application data.
- ExternalAPIs : Represents external services used by the application. - Farmer : Represents individual farmers interacting with the system

Deployment Diagram Explanation :

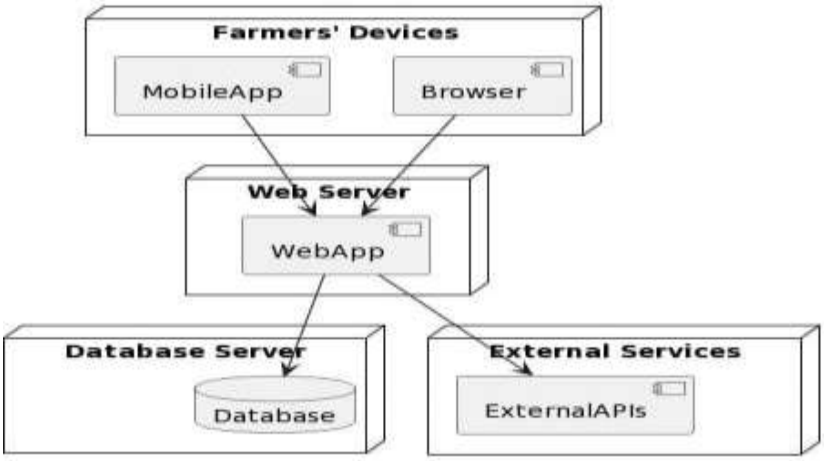

Figure 5.8. Deployment Diagram

- Web Server : Hosts the web application components.
- Database Server : Hosts the application database.
- External Services : Represents external APIs used by the application.
- Farmers' Devices : Devices (browsers and mobile apps) used by farmers to access the web application.

Object Diagram Explanation:

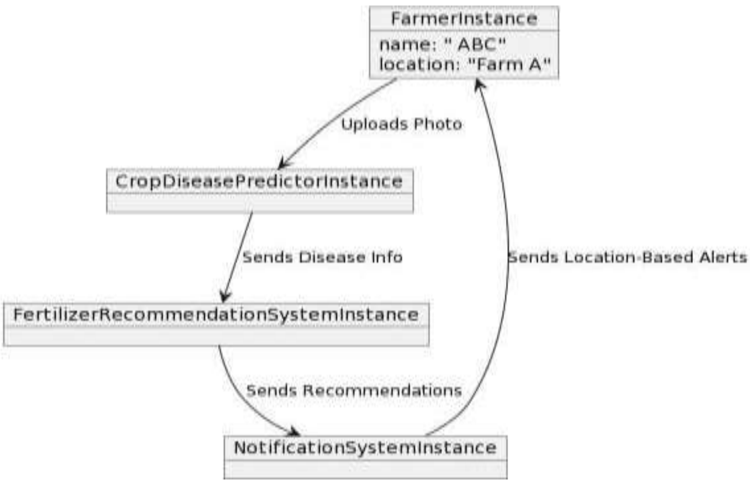

Figure 5.9. Object Diagram

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- Farmer Instance : An instance of the Farmer class representing a farmer named John Doe located at Farm A.
- Crop Disease Predictor Instance : An instance of the Crop Disease Predictor class.
- Fertilizer Recommendation System Instance : An instance of the Fertilizer Recommendation System class.
- Notification System Instance : An instance of the Notification System class.

Use-case diagram :

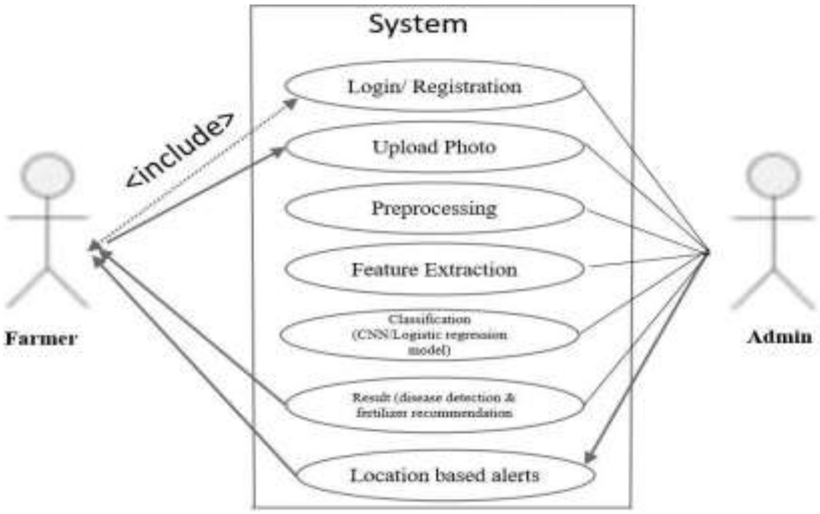

Figure 5.10. Use-case Diagram

- Farmer (Actor): Interacts with the system. Use Cases:
- Log in/registration
- Upload Photo: Farmer uploads a photo for disease detection.
- Detect Disease: System detects disease from the uploaded photo.
- Recommend Fertilizer: System recommends fertilizer based on the detected disease. - Send Alerts: System sends location-based alerts to nearby farmers

Activity Diagram Explanation:

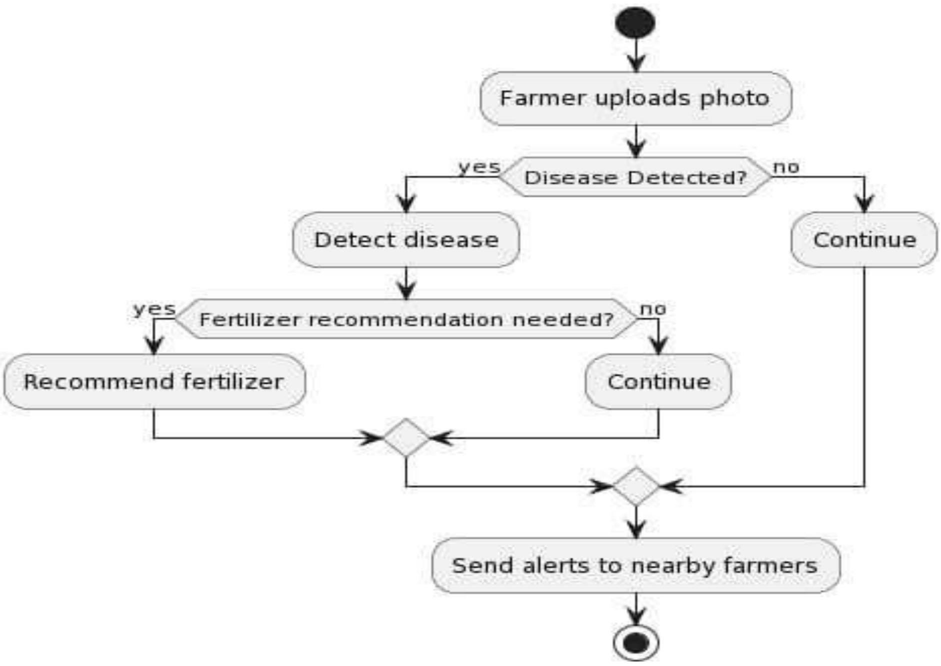

Figure 5.11. Activity Diagram

The farmer uploads a photo.

- If a disease is detected, the system recommends fertilizer.
- Alerts are sent to nearby farmers.
- The process stops.

State Machine Diagram Explanation:

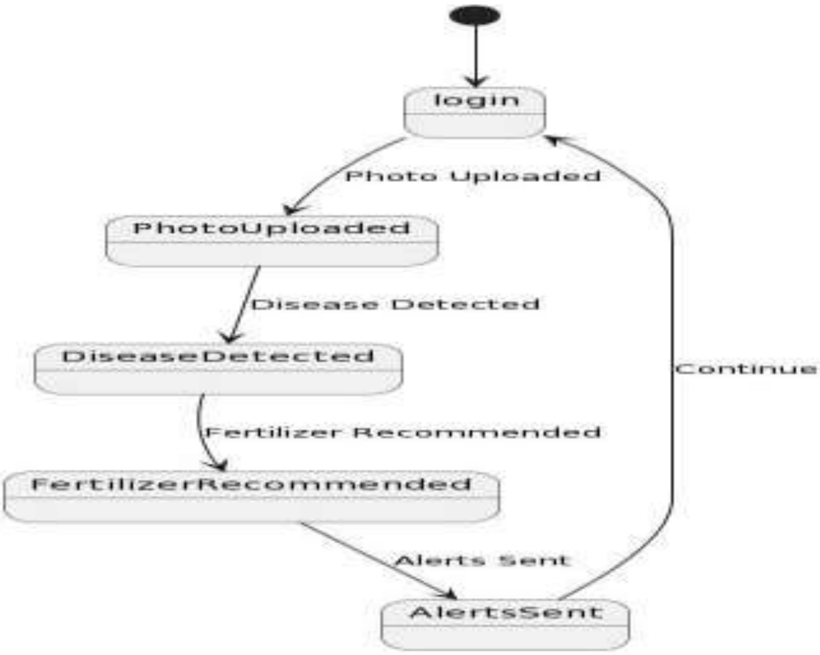

Figure 5.12 State Machine Diagram

- login: Initial state.
- PhotoUploaded: Transition when a photo is uploaded.
- DiseaseDetected: Transition when a disease is detected.
- Fertilizer Recommended : Transition when fertilizer is recommended.
- Alerts Sent: Transition when alerts are sent.
- The process loops back to login after completing.

Sequence Diagram Explanation:

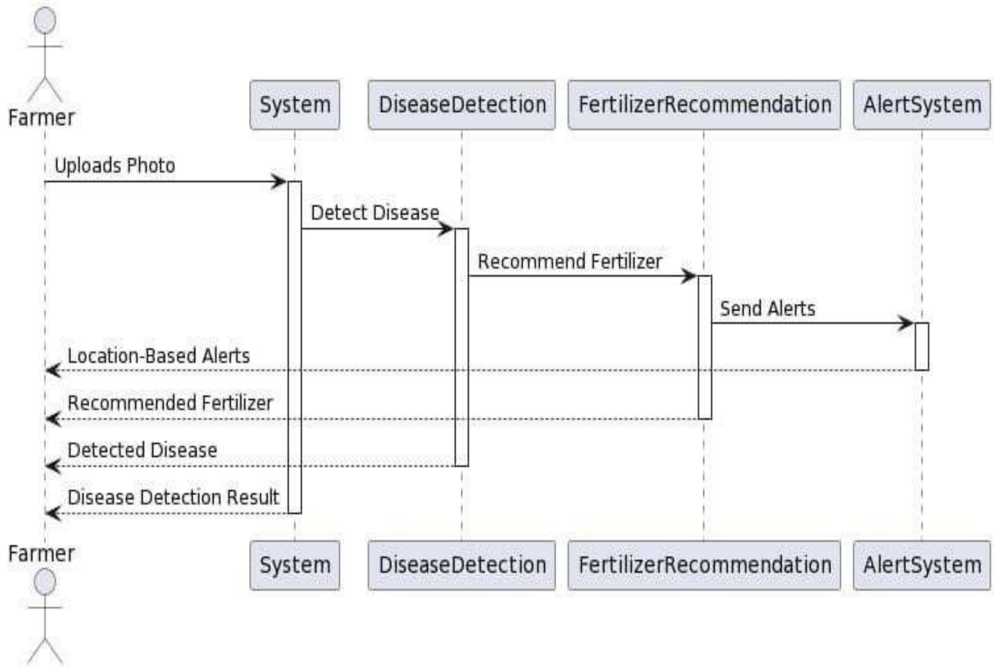

Figure 5.13. Sequence Diagram

- Farmer uploads a photo to the System.
- System detects the disease using DiseaseDetection.
- DiseaseDetection recommends fertilizer through FertilizerRecommendation.
- FertilizerRecommendation sends alerts using AlertSystem. - Results are sent back to the Farmer

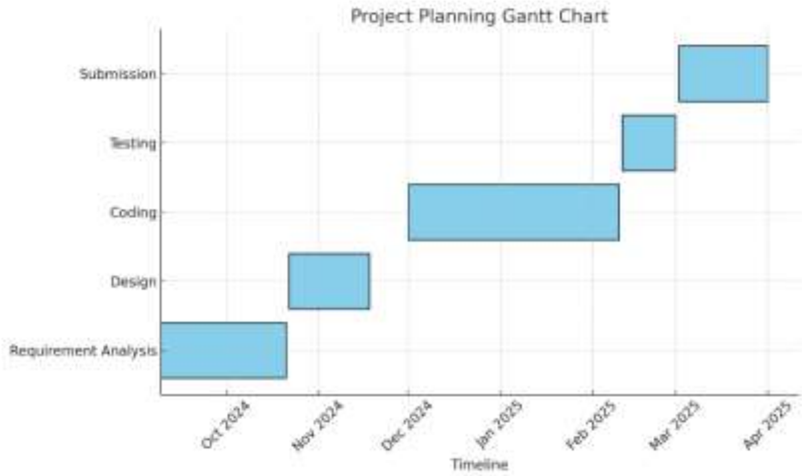

Fig.5.13 Gantt Chart

6. CONCLUSION

1. Holistic Solution for Agricultural Challenges:

   Our application stands as a testament to the transformative power of technology in agriculture. By accurately predicting crop diseases, offering personalized fertilizer recommendations, and fostering collaborative community connections, we have created a comprehensive platform that addresses the multifaceted challenges faced by farmers. This holistic approach ensures that farmers receive tailored guidance, enabling them to make informed decisions that positively impact their crop yields and overall productivity.

2. Revolutionizing Sustainable Agricultural Practices:

   The successful implementation of our application holds the promise of revolutionizing sustainable agricultural practices. Early detection of crop diseases, precise fertilizer recommendations, and community collaboration empower farmers to optimize their farming techniques. This not only leads to higher crop yields but also contributes significantly to environmental sustainability by reducing the unnecessary use of pesticides and fertilizers. By promoting eco-friendly farming practices, our application aligns with global efforts to conserve the environment and promote responsible agriculture.

3. Vision for the Future:

   As we move forward, our vision extends beyond the current achievements. We are committed to refining our system continually. This includes ongoing enhancements to our disease prediction algorithms, further optimizing fertilizer recommendations, and exploring innovative ways to promote community engagement. By embracing emerging technologies and staying at the forefront of agricultural innovation, we aim to expand the impact of our application. Through partnerships, research collaborations, and a dedicated focus on user feedback, we aspire to create a dynamic and evolving platform that caters to the ever-changing needs of farming communities.

4. Enhancing the Well-being of Farming Communities:

   At the heart of our initiative lies the well-being of farming communities. By empowering farmers with valuable insights, knowledge sharing, and personalized recommendations, we are not only enhancing their agricultural productivity but also fostering a sense of confidence and self-reliance. Informed farmers are better equipped to tackle challenges and adapt to changing agricultural landscapes, leading to improved livelihoods and strengthened agricultural economies.

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