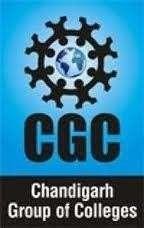


PLANT DISEASE DETECTION

## Project-I

**BACHELOR OF TECHNOLOGY**

(Robotics and Artificial Intelligence)



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# INTRODUCTION

Plant disease detection is a crucial aspect of agriculture that helps ensure food security, improve crop yield, and minimize economic losses. Diseases in plants can be caused by various factors, including bacteria, fungi, viruses, and environmental stressors. Early and accurate detection is essential for effective disease management and control. Traditional manual methods of disease detection are often time-consuming and subjective. However, modern advancements in technology, including artificial intelligence (AI), machine learning (ML), and computer vision, have revolutionized plant disease detection, making it more efficient and precise.

## Scope of the Work

Plant disease detection is an essential area of research and application in agriculture, aimed at improving crop health, increasing yields, and reducing losses due to infections. The scope of this work extends across multiple disciplines, incorporating advanced technologies for accurate and timely disease diagnosis.

### Disease Identification and Classification

* + - * Detection of diseases in plants at various growth stages.
      * Categorization of diseases based on their causes (fungal, bacterial, viral, or environmental stressors).
      * Differentiation between biotic and abiotic factors affecting plant health.

### Technological Applications

* + - * **Machine Learning & AI:** Developing AI-driven models for automatic disease recognition.
      * **Computer Vision:** Image processing techniques for identifying disease patterns.
      * **Remote Sensing & Drones:** Large-scale monitoring of crop health.
      * **IoT-Based Monitoring:** Real-time environmental data collection to predict outbreaks.
      * **Mobile Applications:** Smartphone-based tools for instant disease diagnosis.

### Precision Agriculture and Smart Farming

* + - * Development of site-specific disease management strategies.
      * Reduction of chemical pesticide usage through targeted treatment.
      * Enhancing farming efficiency through AI-driven decision-making.

### Data Collection and Analysis

* + - * Creation of datasets for training disease detection models.
      * Integration of real-time weather, soil, and plant health data.
      * Cloud-based platforms for remote disease monitoring.

### Challenges and Future Prospects

* + - * Addressing variations in disease symptoms across different plant species.
      * Development of cost-effective solutions for small-scale farmers.
      * Advancement of AI accuracy and real-time detection methods.
      * Use of blockchain for secure data sharing in disease tracking.

### Commercial and Industrial Applications

* + - * Deployment of AI-powered detection tools in agribusiness.
      * Collaboration between technology firms and agricultural organizations.
      * Expansion of the market for smart farming solutions.

## Background and Proposed Work

Plant diseases are a major threat to global agriculture, causing significant economic losses and reducing food security. Traditionally, farmers rely on manual inspection and expert knowledge to diagnose plant diseases, which is often time-consuming, subjective, and prone to errors. Advances in technology, particularly artificial intelligence (AI), machine learning (ML), computer vision, and the Internet of Things (IoT), have transformed the way plant diseases are detected and managed. These modern techniques provide more accurate, efficient, and scalable solutions for disease identification and prevention.

Automated plant disease detection uses image processing, deep learning algorithms, and sensor-based monitoring to identify disease symptoms at an early stage. Machine learning models trained on large datasets can classify diseases based on visual symptoms, while remote sensing technologies like drones and satellite imaging enable large-scale crop monitoring. IoT-based smart farming solutions integrate real-time environmental data to predict and prevent disease outbreaks.

### Proposed Work

The proposed work focuses on enhancing plant disease detection by integrating AI-powered image processing, real-time monitoring, and precision agriculture techniques. The key objectives include:

### Development of an AI-Based Detection Model:

* + Train deep learning models (e.g., CNNs) on a dataset of diseased and healthy plant images.
  + Improve accuracy and efficiency in disease classification.

### Implementation of IoT-Based Monitoring:

* + Deploy sensors to monitor soil moisture, temperature, and humidity.
  + Use real-time data to predict disease outbreaks and suggest preventive measures.

### Integration of Remote Sensing and Drones:

* + Capture high-resolution images of crops using drones for early disease detection.
  + Use multispectral imaging for precise disease identification.

### Development of a Farmer-Friendly Mobile Application:

* + Provide a user-friendly interface for farmers to upload plant images and receive AI-based disease diagnosis.
  + Offer real-time recommendations for disease management and treatment.

# LITERATURE REVIEW

### Traditional Approaches

Early disease detection relied on human expertise and laboratory tests, including microscopic analysis and biochemical testing. While effective, these methods are labor-intensive and not feasible for large-scale farming. Manual scouting remains common but is prone to errors and subjectivity.

### AI and Machine Learning in Disease Detection

Recent studies highlight the effectiveness of AI and ML in automating plant disease diagnosis. Convolutional Neural Networks (CNNs) have shown high accuracy in classifying diseases based on leaf images. Research by Mohanty et al. (2016) demonstrated that deep learning models could achieve over 90% accuracy in plant disease classification. Other ML techniques, such as Support Vector Machines (SVMs) and Random Forest classifiers, have also been explored for feature extraction and classification.

### Remote Sensing and IoT-Based Monitoring

The use of drones and satellite imaging has enhanced large-scale disease monitoring. Multispectral and hyperspectral imaging techniques help detect disease symptoms not visible to the naked eye. IoT sensors collect real-time data on soil moisture, temperature, and humidity to predict disease outbreaks, improving precision agriculture practices.

### Challenges and Future Directions

Despite advancements, challenges such as variations in disease symptoms, limited dataset availability, and the high cost of AI-driven solutions remain. Future research should focus on enhancing model robustness, increasing dataset diversity, and making AI solutions accessible to small-scale farmers.

# PROBLEM FORMULATION

The early detection and diagnosis of plant diseases are critical for ensuring food security and minimizing economic losses in agriculture. Traditional disease identification methods, such as manual inspection and laboratory analysis, are inefficient, labor-intensive, and often inaccurate. The emergence of artificial intelligence (AI), machine learning (ML), and the Internet of Things (IoT) has opened new possibilities for automated, real-time plant disease detection. However, several challenges remain in developing reliable and scalable disease detection systems.

### Problem Statement

The primary challenge in plant disease detection is achieving high accuracy and early identification of diseases while minimizing costs and computational resources. Key issues include:

* **Variability in Disease Symptoms:** Symptoms of plant diseases may vary across species, growth stages, and environmental conditions, making classification difficult.
* **Limited and Imbalanced Datasets:** The availability of large, well-annotated datasets for training AI models is a major bottleneck in achieving high-performance disease detection.
* **Real-Time Processing Limitations:** Most existing AI models require substantial computational power, making real-time, on-field disease detection a challenge.
* **Integration with IoT and Remote Sensing:** While drones and IoT sensors can enhance disease monitoring, integrating these technologies effectively into a scalable system remains a challenge.

### Objectives

This study aims to develop a robust, cost-effective, and scalable plant disease detection system by:

* Implementing deep learning-based models (e.g., CNNs) for accurate disease classification.
* Enhancing dataset diversity and augmenting data to improve model generalization.
* Exploring real-time disease detection methods using edge computing and lightweight AI models.
* Integrating IoT sensors and remote sensing technologies for large-scale monitoring and early disease prediction.

### Proposed Solution

A hybrid approach combining AI, computer vision, and IoT-based real-time monitoring is proposed to address the challenges in plant disease detection. By leveraging deep learning models for image-based classification and sensor data for predictive analysis, this system will provide timely and accurate disease detection while being

accessible to farmers and agribusinesses.

### Conclusion

The formulation of this problem highlights the need for a scalable, accurate, and cost-effective solution for plant disease detection. The proposed approach aims to bridge the gap between traditional methods and advanced AI- driven techniques to improve agricultural productivity and sustainability.

# OBJECTIVES

### Develop an AI-Based Disease Detection Model:

* + Utilize deep learning algorithms, such as Convolutional Neural Networks (CNNs), for accurate disease classification.
  + Train models on diverse and well-annotated datasets to improve accuracy across different plant species.
  + Optimize models to reduce false positives and false negatives, ensuring reliable predictions.

### Enhance Dataset Quality and Model Performance:

* + Collect and preprocess high-quality images of healthy and diseased plants.
  + Use data augmentation techniques like rotation, scaling, and contrast enhancement to improve model generalization.
  + Incorporate expert agricultural knowledge to refine data labeling and classification.

### Enable Real-Time Disease Detection:

* + Develop lightweight AI models optimized for edge computing and mobile applications.
  + Ensure low-latency processing for on-field disease identification.
  + Explore cloud-based and offline AI processing for seamless user experience.

### Integrate IoT and Remote Sensing for Early Disease Prediction:

* + Deploy IoT sensors to monitor environmental factors like temperature, humidity, and soil conditions that influence plant health.
  + Utilize drones and satellite imaging for large-scale disease surveillance.
  + Implement predictive models that combine sensor data with AI for proactive disease prevention.

### Develop a User-Friendly Application for Farmers:

* + Design an intuitive mobile and web application for farmers to upload plant images and receive instant disease diagnoses.
  + Provide actionable insights, including disease descriptions, probable causes, and recommended treatments.
  + Ensure multilingual support and offline functionality to enhance accessibility for rural farmers.

### Ensure Scalability and Cost-Effectiveness:

* + Create an affordable solution suitable for both small-scale farmers and large agricultural enterprises.
  + Optimize computational resources to reduce operational costs while maintaining high accuracy.
  + Collaborate with agricultural organizations and policymakers to facilitate widespread adoption and real-world implementation.

This project aims to bridge the gap between traditional plant disease detection methods and modern AI-driven techniques. By integrating AI, IoT, and remote sensing, the system will provide real-time insights, enhance agricultural productivity, and support sustainable farming practices. The proposed solution will empower farmers with an efficient, accessible, and cost-effective tool for timely disease detection and management.

# PLANNING OF WORK

* The project will be completed in **5 major phases** over **16 weeks**.

### Phase 1: Data Collection & Preprocessing (Weeks 1-4)

* Collect plant disease datasets (PlantVillage, Kaggle, real-world images).
* Apply **data augmentation** (rotation, brightness adjustments, noise reduction).

### Phase 2: Model Development & Training (Weeks 5-8)

* Implement **Convolutional Neural Networks (CNNs)** for image classification.
* Train and fine-tune the model using **transfer learning (ResNet, MobileNet)**.
* Validate accuracy using **precision, recall, F1-score metrics**.

### Phase 3: Mobile App Development (Weeks 9-12)

* Develop the **mobile app using Flutter/React Native**.
* Integrate the AI model for real-time disease detection.
* Design an intuitive UI/UX for easy navigation.

### Phase 4: Testing & Optimization (Weeks 13-15)

* Conduct **field testing** on real plant images.

### Optimize inference speed, memory usage, and user experience.

* **Phase 5: Deployment & Documentation (Week 16)**
* Deploy the app on **Google Play Store & Apple App Store**.
* Prepare **project documentation and user manuals**.

# FACILITIES REQUIRED

To successfully implement this project, the following resources will be required:

### Software Requirements:

* Python (for model training)
* TensorFlow / Keras (deep learning framework)
* OpenCV (image processing)
* Flutter / React Native (mobile app development)

### Hardware Requirements:

* High-performance **GPU-enabled system** for training deep learning models
* Smartphones for real-world app testing
* Cloud storage for dataset hosting

### Other Requirements:

* Access to large plant disease image datasets
* Internet connectivity for model deployment and real-time predictions

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