

Agribot: Plant Disease Detection and Spraying Robot

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Abstract- This project focuses on developing a Smart Agricultural Machine for Automatic Sapling Plantation using Arduino UNO. The system automates the plantation process to reduce human effort and improve farming efficiency. It operates through a continuous cycle of movement, distance sensing, and sapling planting. An HC-SR04 ultrasonic sensor is used to maintain proper spacing between saplings. DC motors, controlled by an L293D motor driver, enable the movement of the machine. A servo motor handles the planting mechanism by placing saplings into the soil. The Arduino UNO coordinates sensor inputs and motor operations for smooth functioning. The machine is powered by a 12 V battery, making it suitable for field use. This solution helps save time, ensures uniform plantation, and lowers labour requirements. The project supports modern smart farming practices by integrating automation and embedded technology.

Keywords: Smart Agriculture , Automatic Sapling, Plantation, Ultrasonic Sensor, Automation, Smart Farming

Introduction: Agribot is an intelligent agricultural robot designed for automatic plant disease detection and pesticide spraying. The system addresses challenges related to manual disease monitoring and inefficient pesticide application. A Raspberry Pi and Pi Camera are used to capture and analyze plant images in real time. Machine learning and image processing

techniques help identify disease symptoms accurately. Once an infected area is detected,

the robot activates a spraying mechanism to apply pesticides only where needed. DC motors

and an L298N motor driver control the robot's movement, while a mini pump performs the spraying operation. This targeted approach reduces chemical wastage and improves crop protection. The integration of artificial intelligence and robotics enhances farming efficiency and accuracy. The project supports sustainable agricultural practices by minimizing environmental impact. Overall, Agribot demonstrates the role of smart technologies in improving agricultural productivity and resource management.

Proposed Solution- The proposed Agribot system provides an automated method for monitoring plant health and controlling diseases. It uses a Raspberry Pi as the main controller along with a camera module to capture images of plant leaves. The captured images are processed using OpenCV techniques to improve image quality and extract useful features. A Convolutional Neural Network

(CNN) model developed with TensorFlow analyzes the images to detect signs of disease. The system continuously monitors crops and identifies infected plants in real time. When a disease is recognized, the robot automatically activates a pesticide spraying mechanism. Pesticides are applied only to the affected regions, ensuring precise treatment. This reduces unnecessary chemical usage and lowers operational costs. The automated process improves disease management and crop protection. Overall, the system enhances agricultural productivity through intelligent monitoring and targeted spraying.

Key Contribution- Agribot is a technology-driven farming system that helps monitor plant health and manage diseases automatically. It uses intelligent image analysis to identify infected plants and applies pesticides only where treatment is needed. This approach helps conserve chemicals and reduces human effort in agricultural activities. The system improves the accuracy of disease control while lowering farming costs. By combining automation and smart decision-making, it supports efficient and sustainable crop production.

Literature Review- Several research studies have explored Agribot. This Section reviews relevant work that forms the foundation for our proposed system.

Santhosh et al. (2023) ...[1]

Designed Agni, a robotic system capable of autonomously detecting plant diseases and supporting farmers with automated field monitoring. Their model integrates mechanical mobility and machine-vision techniques to identify infected plants and assist in precision agriculture practices.

Dhumale and Bhaskar (2021) ...[2]

Proposed a smart agricultural robot capable of pesticide spraying and leaf-disease detection using image-processing techniques. Their approach emphasizes reducing manual labor and improving pesticide accuracy by identifying diseased leaf regions before spraying.

Destreza et al. (2025) ...[3]

Developed a CNN-based Smart Agribot utilizing the EfficientDet architecture for detecting disease in green beans and performing automatic pesticide spraying. Their work highlights real-time disease recognition, precise chemical application, and autonomous navigation for crop-health management.

Shetty et al. (2021) ...[4]

Developed an Agribot system for plant disease detection and pesticide **spraying**, leveraging computer-vision techniques to classify diseased leaves. The robot aims to reduce farmers' exposure to harmful chemicals and enhance field productivity by performing targeted pesticide application.

Sai Krishna et al. (2018) ...[5]

Implemented a robot-based plant disease detection system using MATLAB image processing and SVM classification. The robot autonomously navigates farms, captures leaf images, and identifies disease symptoms to support early intervention and increased crop yield.

Amrita et al. (2025) ...[6]

Presented a deep learning-based plant disease detection model employing convolutional neural networks to classify plant infections accurately. Their approach improves automated diagnosis for agricultural environments, achieving enhanced recognition accuracy

.Shinde et al. (2024) ...[7]

Introduced a digital farming solution integrating Agri-Bot, Agri-Drone, and Agri-AGV platforms for organic farming. Their work focuses on automation for grafting, spraying, crop monitoring, and harvesting, demonstrating the future of AI-enabled precision agriculture.

Wyawhare et al. (2023) ...[8]

Developed an Agribot system utilizing YOLO and Darknet for weed detection, disease diagnosis, and depth estimation in agricultural fields. The system supports real-time plant-health monitoring and ensures precise intervention for optimized crop management. Developed a CNN-based Smart Agribot utilizing the EfficientDet architecture for detecting disease in green beans and performing automatic pesticide spraying. Their work highlights real-time disease recognition, precise chemical application, and autonomous navigation for crop-health management.

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Methodology- The proposed Agribot operates by combining image analysis and automated spraying to support smart farming. A camera connected to the Raspberry Pi continuously captures pictures of plant leaves during field movement. These images are refined using OpenCV techniques to improve clarity and prepare them for analysis. The processed images are then examined by a TensorFlow-based CNN model trained to recognize symptoms of plant diseases. The model identifies whether a plant is healthy or infected and sends the result to the control unit. Based on this outcome, the Raspberry Pi decides the next operation. If the plant is healthy, the robot proceeds to inspect other crops. When disease symptoms are detected, a spraying mechanism is triggered automatically. A pump and nozzle dispense pesticide only on the affected plant, preventing excessive chemical use. The robot's movement is managed through DC motors and a motor driver module. This approach enables timely disease identification, precise treatment, and efficient crop monitoring with minimal human involvement.

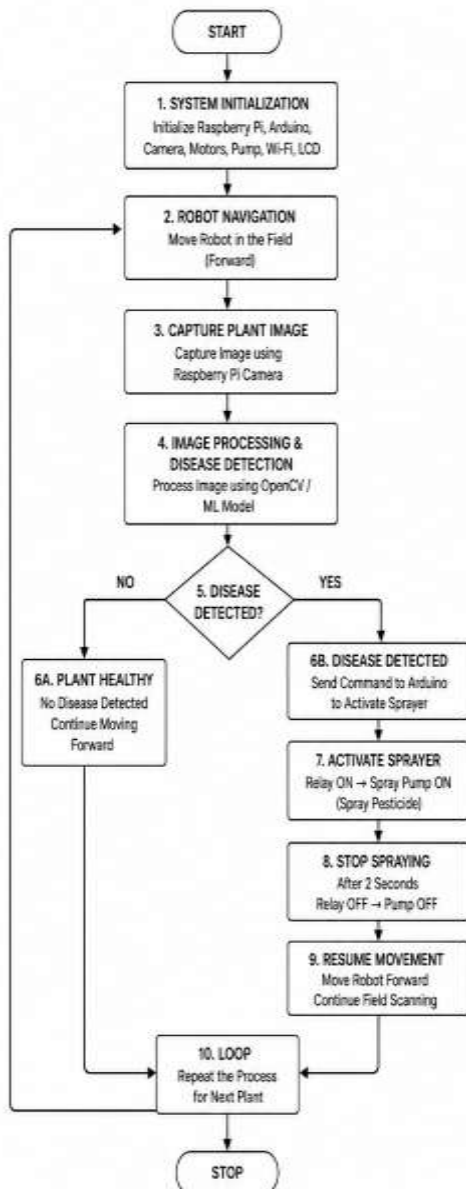
System Overview-

Agribot is a smart farming robot developed for automatic plant disease detection and targeted pesticide spraying. The system uses a Raspberry Pi as the main controller and a camera module to capture images of crop leaves. These images are processed using OpenCV and analyzed by a CNN-based machine learning model to identify diseases. Based on the detection result, the robot decides whether spraying is required. If an infected plant is found, the spraying unit applies pesticide only to the affected area. The robot moves through the field with the help of DC motors and a motor driver. This automated approach improves crop monitoring, reduces chemical wastage, and decreases the need for manual labor. Overall, the system supports efficient and sustainable agricultural practices.

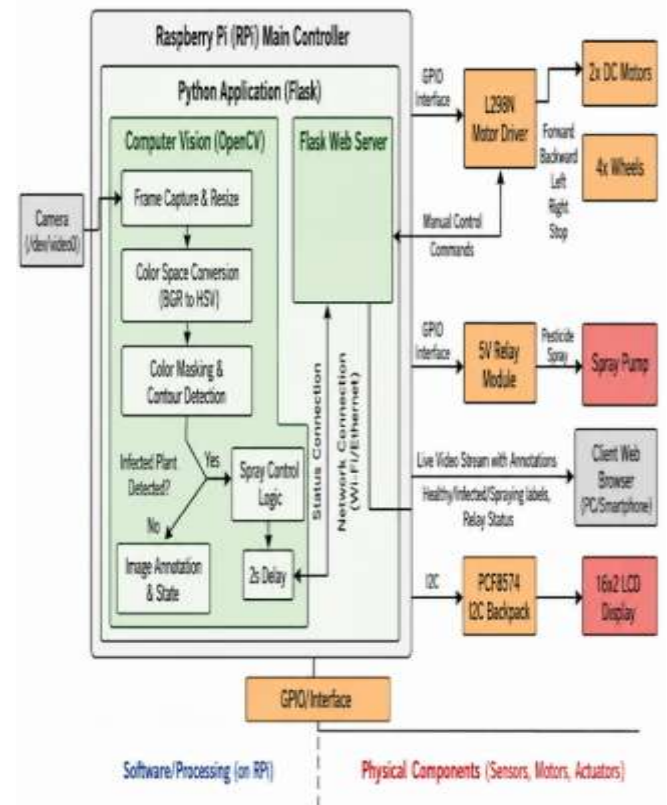
Table 1
Comparison Of PLANT DISEASE DETECTION AND SPARYING SYSTEM

Title	Technology Used	Performance Metrics	Advantages	Limitations
Agni Robot (2023)	Robotics, Computer Vision	Disease detection accuracy around 85-90%	Supports automatic crop inspection and monitoring	Spraying mechanism is not highly precise
Smart Agri Robot(2021)	Image processing, Automated Sprayer	Moderate detection efficirncy	Reduces manual effort in pesticide application	Limited intelligence is not highly precise
CNN-Based Agribot(2025)	CNN, EfficintDet, Deep Learning	Accuracy greater than 90%	Fast disease recognition with targeted spraying	Requires high computational resources
Plant Disease Detection System(2021)	OpenCV, Image Analysis	Medium classification accuracy	Easy implementation and low-cost setup	Performance affected by image quality
Robotics Disease Detection Model(2018)	MATLAB, SVM Classifier	Accuracy between 75-90%	Supports early disease identification	Manual feature extraction required
Deep Learning Disease Classifier(2025)	CNN, Artificial Intelligence	High prediction accuracy	Effective recognition of multiple diseases	Needs a large training dataset
Automated Spraying Robot(2024)	Mechanical Sprayer, Embedded Control	Moderate spraying performance	Simple design and easy operation	Lacks intelligent disease detection
Proposed Agribot System	Raspberry Pi, Camera Module, OpenCV, TensorFlow CNN	High disease detection accuracy with selective spraying	Combines monitoring, disease detection, and precision spraying in one platform	Performance depends on model training quality and camera resolution

Flow Chart-



Block Diagram-



Hardware Components-

The Agribot incorporates:

- Raspberry Pi 4 Model B for central processing and control
- Raspberry Pi Camera Module V2 for real-time image capture
- L298N Motor Driver Module for controlling DC motors
- DC Motors for robot movement across the field
- Mini Water Pump for pesticide spraying
- Nozzle for targeted and precise spraying

- Raspberry Pi 4 for data processing and display
- Rechargeable Battery for power supply

Software Architecture-

The software implementation consists of:

- OpenCV library for image preprocessing and enhancement
- Raspberry Pi OS for system operation
- ThingSpeak platform for data analytics and visualization
- Flutter-based cross-platform mobile application
- RESTful APIs for data exchange between components

Implementation and Testing-

The system implementation involved extensive hardware integration, software development, and comprehensive testing phases. This section details the implementation process and experimental validation.

Hardware Implementation-

The hardware architecture of Agribot is designed to support automated crop monitoring and pesticide spraying. The Raspberry Pi 4 serves as the central processing unit, coordinating image analysis, movement control, and spraying operations. It receives input from the camera module and generates control signals for the other hardware components. This compact and energy-efficient controller enables real-time decision-making within the system. To

capture crop images, a Raspberry Pi Camera Module is mounted on the robot. The camera continuously acquires images of plant leaves as the robot moves through the field. For mobility, DC motors are connected to an L298N motor driver, which regulates the speed and direction of the robot. This arrangement allows smooth navigation between crop rows and supports effective field coverage during operation.

The spraying mechanism consists of a mini water pump, a nozzle, and a relay interface controlled by the Raspberry Pi. When the system identifies a diseased plant, the pump is activated automatically, delivering pesticide directly to the affected area. A rechargeable battery powers all hardware units, ensuring uninterrupted operation in outdoor environments. The combination of these components enables efficient disease management while reducing manual effort and chemical wastage.

Software Implementation-

The software framework of Agribot is responsible for image processing, disease identification, and system control. The Raspberry Pi runs the application software on Raspberry Pi OS, which manages communication between all modules. The software continuously receives images from the camera and processes them for further analysis. This enables the system to monitor crop conditions in real time and respond quickly to any detected disease.

OpenCV is used to prepare the captured images before classification. The preprocessing stage includes resizing images, reducing noise, and improving image quality to obtain better detection results. After preprocessing, the images are passed to a Convolutional Neural Network (CNN) model developed using TensorFlow. The trained model analyzes leaf features and determines whether the plant is healthy or affected by a disease.

Based on the prediction generated by the CNN model, the control program executes the required action. If the plant is healthy, the robot continues its inspection process. When a disease is detected, the software sends commands to activate the spraying unit and apply pesticide to the infected area. This integration of image processing, machine learning, and automated control allows Agribot to perform accurate disease detection and precision spraying with minimal human intervention.

Results and Discussion-

The developed Agribot system was tested to evaluate its ability to detect plant diseases and perform automatic pesticide spraying. During testing, the camera successfully captured leaf images under different field conditions and transmitted them to the Raspberry Pi for analysis. The image preprocessing stage improved image quality, enabling the CNN model to identify disease symptoms more effectively. The trained model accurately classified healthy and infected leaves and generated results within a short processing time. Whenever a diseased plant was detected, the spraying unit was activated automatically and applied pesticide only to the affected region. The robot also maintained smooth movement between crop rows without interrupting the detection process. The overall performance demonstrated reliable disease recognition and efficient spraying, making the system suitable for practical agricultural applications.

In discussion, The experimental results show that the Agribot system can effectively detect plant diseases and perform automatic pesticide spraying. The combination of image processing and deep learning improves the accuracy of disease identification compared to manual inspection. Targeted spraying helps reduce unnecessary pesticide usage and lowers environmental impact. The system also decreases the need for continuous human monitoring, saving time and labor.

The Raspberry Pi-based design provides a low-cost and efficient solution for smart farming applications. However, detection performance may vary due to changes in lighting conditions, image quality, and dataset size. Further improvements in navigation and model training can enhance overall system reliability. The proposed Agribot demonstrates the potential of intelligent automation in achieving sustainable and precision agriculture.



System Performance Evaluation-

The performance of the Agribot system was evaluated based on disease detection accuracy, response time, spraying efficiency, and overall operational reliability. The CNN-based model successfully identified diseased and healthy leaves with high accuracy, enabling timely treatment of infected plants. The image processing and classification stages were completed within a short duration, allowing near real-time decision-making. The spraying mechanism responded correctly whenever disease symptoms were detected, ensuring precise pesticide application. The robot maintained stable movement while continuously monitoring crops, demonstrating reliable field operation. In addition, targeted spraying reduced chemical wastage and improved resource utilization. The results confirm that the proposed system can effectively support plant health monitoring and automated crop protection. Overall, Agribot provides an efficient, accurate, and cost-effective solution for modern precision agriculture.

Conclusion-

The proposed Agribot system demonstrates the effective use of artificial intelligence and robotics in modern agriculture. By combining image processing, deep learning, and automated spraying, the system is capable of identifying plant diseases at an early stage and providing timely treatment. The Raspberry Pi and camera module work together to capture and analyze leaf images, while the CNN model accurately classifies plant health conditions.

Upon detecting an infected plant, the spraying mechanism applies pesticide only where required, reducing unnecessary chemical usage.

The implementation of this system offers several advantages, including reduced pesticide consumption, lower environmental impact, decreased labor requirements, and improved crop protection. The results show that intelligent image-based disease detection can enhance farming efficiency and support better decision-making in crop management. The system also provides a practical and affordable solution for precision agriculture.

In conclusion, Agribot represents an important step toward automated and sustainable farming practices. The successful integration of embedded systems, machine learning, and robotic technology highlights its potential for real-world agricultural applications. With future improvements such as advanced navigation, IoT connectivity, and support for multiple crop varieties, the system can become a more versatile and effective tool for smart agriculture.

Future Work-

1. **Drone-Based Implementation:**

The concept can be extended to aerial spraying drones for covering large-scale farms and inaccessible terrains.

2. **Multi-Crop and Multi-Disease Classification:**

The system can be trained using deep learning models (CNN, VGG16, ResNet) on datasets of multiple crops for broader applicability.

3. **GPS and Sensor Fusion Navigation:**

Incorporating GPS, LiDAR, or ultrasonic sensors would enable autonomous navigation, path planning, and obstacle avoidance.

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