Plant Disease Identification Using IOT and AI

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***Abstract*—Agriculture plays a vital role in sustaining the** global **economy, but plant diseases significantly reduce crop productivity and quality. Early detection and diagnosis of plant diseases are essential to minimize losses and ensure food security. This project focuses on developing an IoT and AI-based system for automatic plant disease identification.**
The system integrates Internet of Things (IoT) sensors to continuously monitor environmental parameters such as temperature, humidity, and soil moisture, which influence disease occurrence. A camera module captures real-time images of plant leaves, which are then processed using Artificial Intelligence (AI) techniques—specifically, machine learning and deep learning algorithms (like Convolutional Neural Networks)—to detect and classify plant diseases accurately.
Collected data is transmitted to a cloud-based platform for analysis and storage. The system provides farmers with instant alerts and disease prevention suggestions via a mobile or web application. This smart approach enables real-time monitoring, early disease prediction, and timely intervention, leading to improved crop health and increased agricultural productivity.
The proposed model demonstrates how combining IoT and AI technologies can revolutionize precision agriculture and promote sustainable farming practices.

***Index Terms*—IoT, Artificial Intelligence, Machine Learning, Deep Learning, CNN, Smart Agriculture, Plant Disease Detection.**

I. INTRODUCTION

Agriculture is the backbone of many economies, and ensuring healthy crop production is essential for food security and sustainability. However, plant diseases pose a major challenge to farmers, leading to significant yield losses and economic damage. Traditional methods of disease detection rely on manual observation by experts, which is time consuming, labor-intensive, and often inaccurate.

To overcome these limitations, this project proposes a smart plant disease identification system that integrates Internet of Things (IoT) technology with Artificial Intelligence (AI). The system aims to monitor plant health in real time and automatically identify diseases at an early stage.

IOT sensors such as temperature, humidity, soil moisture, and light intensity sensors continuously collect environmental and soil data from the field. These parameters are transmitted to a central server or cloud platform through wireless communication modules (like Wi-Fi, GSM, or LoRa). Simultaneously, cameras or imaging sensors capture pictures of plant leaves.

Using AI-based image processing and machine learning algorithms, these images are analyzed to detect symptoms such as spots, color changes, or deformities that indicate specific diseases. The trained AI model classifies the disease and provides recommendations for treatment or preventive measures.

This integration of IoT and AI enables early detection, precision agriculture, and data-driven decision making, helping farmers improve productivity, reduce chemical usage, and minimize crop losses.

Key Features:

- Real-time monitoring of environmental conditions using IoT sensors

- Image-based disease detection using AI and deep learning models
- Cloud-based data storage and analytics

Mobile or web application interface for farmers INCIEDENTS

- The team structured the paper into standard research sections — Abstract, Introduction,

Literature Review, Methodology,

Experimental Results, and Conclusion. Data collected from IoT sensors (temperature, humidity, soil moisture) and AI-based leaf image classification results were included.

- The paper was submitted through the conference/journal's online portal. It underwent a double-blind peer-review process, where reviewers provided comments and suggestions for improvement, particularly emphasizing dataset diversity and model validation.
- Based on the reviewers' feedback, improvements were made to enhance result accuracy and provide deeper analysis of model performance metrics (accuracy, precision, recall, F1-score).
- The paper was accepted for publication after the second round of review. The acceptance letter confirmed its inclusion in the conference proceedings/journal issue. The authors presented their work during the technical session, receiving positive feedback from experts in AI and smart agriculture.
- The publication of this paper contributed to the academic recognition of the project,

High lighting its innovation in combining IoT based environmental sensing with AI powered image classification. It also encouraged further research collaboration and extension into precision agriculture applications.

II. PROPOSED SYSTEM

IoT Module: Includes DHT11 (temperature and humidity), soil moisture sensors, and a camera. The sensors transmit data via Wi-Fi or GSM to a cloud database.

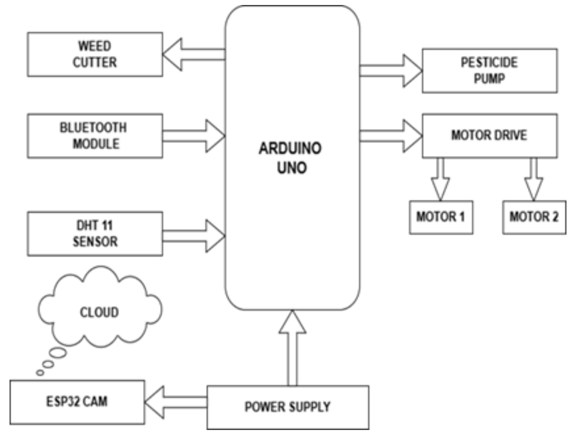


Fig. 1. Block diagram of the proposed system

AI Module: A CNN model processes plant leaf images and classifies diseases like leaf spot, mildew, or blight. The trained model achieves high accuracy by using image preprocessing and data augmentation techniques.

III. METHODOLOGY AND WORKING

The proposed methodology involves the development of an autonomous agricultural rover system that utilizes Convolution Neural Networks (CNNs) for plant disease identification and automated fertilizer application. The process begins with the collection and segregation of a large dataset of plant images with various diseases, which is then used to train a CNN model. The trained model is integrated with a rover equipped with a higher solution camera and sensors to monitor soil conditions along with weed cutting mechanism which helps to cut the weed. The system identifies plant diseases in real-time and applies fertilizers precisely based on the identified disease. The entire system is tested and validated in various agricultural environments to assess its accuracy, reliability, and effectiveness. The diagram illustrates a system that appears to be an automated agricultural robot or a smart farming device. The central component is the Arduino Uno, a microcontroller board that serves as the brain of the system.The block diagram represents a solar-powered embedded system using an Arduino Uno for control. The system begins with a solar panel that supplies energy to a 12V battery, which stores the collected power.

▪This 12V power is then fed into a power supply module that converts it to suitable voltage levels such as 12V, 5V, and 3V, which are required by different components in the system.

▪The Arduino Uno receives power from this setup and acts as the main controller. It is connected to ultrasonic sensors that detect the presence or distance of an object.

▪Based on the sensor input, the Arduino controls two LEDs — a red LED and a green LED — which likely serve as status indicators. The red LED may indicate an obstacle or warning, while the green LED may signal a clear or safe condition.

AI

Artificial intelligence (AI) is technology that allows computers and machines to perform tasks that typically require human intelligence, such as learning, reasoning, problem-solving, and decision making. It works by using algorithms and data to recognize patterns and make predictions or decisions, and it is used in a wide range of applications, from virtual assistants and recommendation systems to self-driving cars and disease detection.

Simulates human intelligence: AI aims to give machines capabilities like learning, comprehension, and problem-solving.

Learns from data: AI systems can automatically learn from and adapt to new data without human intervention, a subset of which is machine learning.

IMAGE PROCESSING

Image processing with AI involves using artificial intelligence and machine learning, particularly deep learning models like convolutional neural networks (CNNs), to enable computers to understand, interpret, and manipulate visual data like images and videos. This technology is used for tasks such as object recognition, facial recognition, image enhancement, and generating new images, with applications spanning industries like healthcare, retail, and security.

Training with data: AI algorithms are trained on vast datasets of images to learn to recognize patterns and features.

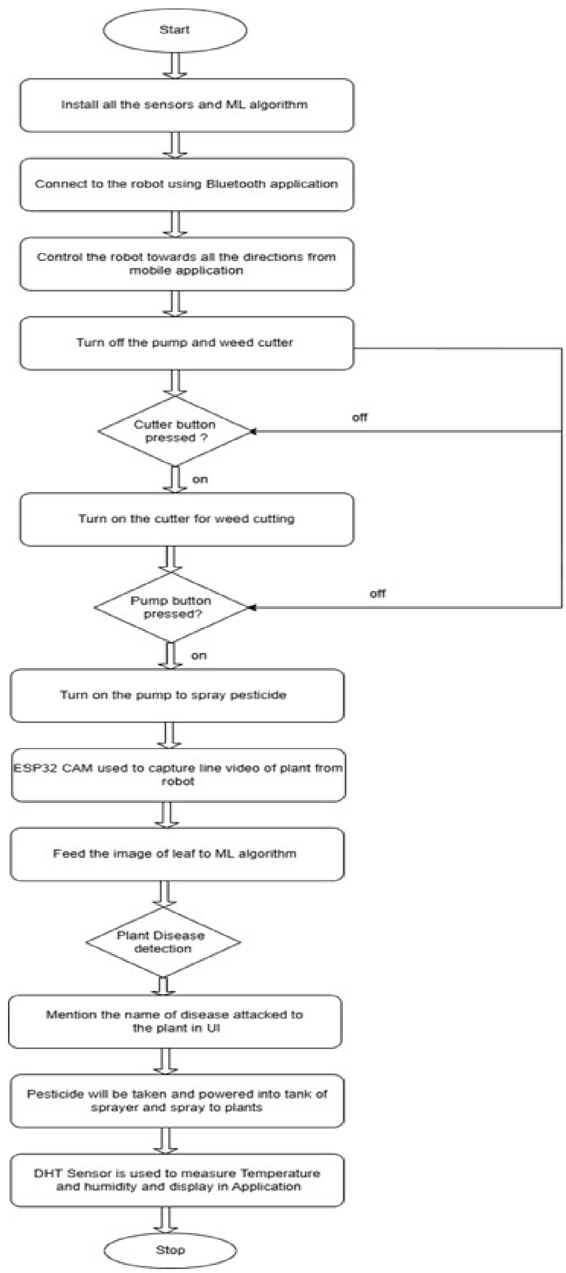
Core technology: Neural networks, which mimic the human brain, are central to this process. They learn from the data and predict or classify outcomes.

Key algorithms: Deep learning, especially CNNs, is crucial for extracting features and achieving high accuracy in image classification and other tasks.

IOT

IoT, or the Internet of Things, is a network of physical objects with sensors and software that connect to the internet to exchange data. These "things" can range from smart home appliances and wearables to complex industrial machinery, enabling them to communicate with each other and with users without direct human intervention. The goal is to create self-reporting and interconnected systems that can perform tasks and provide real-time insights, improve efficiency, and enable automation.

FLOW CHART



The flow chart illustrates the complete operational workflow of an intelligent agricultural robot designed for automated field monitoring, weed management, and plant disease detection. The process begins with integrating all necessary hardware components—such as sensors, the ESP32 CAM module, the DHT environmental sensor, and the weed-cutting and pesticide-spraying units—along with deploying the trained machine-learning algorithm onto the system. After successful installation, the robot is paired with a mobile device through a Bluetooth-based application, enabling the user to manually navigate the robot across the field. For safety and controlled operation, both the weed cutter and pesticide pump remain in the off state until explicitly activated by the user. When the cutter button is pressed in the mobile app, the weed-cutting mechanism engages to clear unwanted vegetation, whereas pressing the pump button activates the pesticide-spraying module. As the robot moves, the ESP32 camera continuously captures live video frames of plant leaves, which are then processed by the ML algorithm to analyze visual symptoms and detect possible plant diseases. Upon detection, the system immediately displays the name of the identified disease on the user interface, helping the user take timely action. The appropriate pesticide is then selected, filled into the sprayer tank, and automatically sprayed onto the affected plants to prevent further spread. Additionally, the onboard DHT sensor monitors and records the surrounding temperature and humidity levels, sending this real-time environmental data to the application for better field assessment. This integrated workflow ensures improved crop health monitoring, targeted pesticide usage, and enhanced precision agriculture.

PLANT DIESEASE IDENTIFICATION

Tomato Mosaic Virus

Fig: Tomato Mosaic Virus

Tomato mosaic virus (ToMV) is a plant disease that causes mottling, blistering, and distortion of tomato leaves, stunting, and reduced fruit yield. It spreads through contact with infected plants, contaminated tools, clothing, or seeds. Management focuses on sanitation, including washing hands and disinfecting tools, removing infected plants, using disease-resistant varieties, and starting with disease-free seeds.

Target spot

Fig: Target spot

Target spot disease is a fungal disease affecting various plants, characterized by circular lesions with concentric rings on leaves, stems, and sometimes fruit. It is caused by different fungi depending on the host, such as for cotton and soybeans, or for potatoes. Management involves cultural practices like improving air circulation and sanitation, using resistant varieties where available, and applying fungicides if necessary.

Tomato yellow leaf

Fig: Tomato yellow leaf

Tomato yellow leaf curl virus (TYLCV) is a highly destructive virus that causes significant yield loss in tomato plants, characterized by yellowing, curling, and stunting of leaves. It is transmitted by the and is a serious problem in tropical and subtropical regions worldwide. Other symptoms include reduced plant size, flower abortion, and a bushy appearance.

Late Blight

Fig: Late blight

Late blight is a destructive disease in tomatoes caused by the pathogen Phytophthora infestans, characterized by water-soaked lesions on leaves and stems and dark brown, firm lesions on fruit. The disease thrives in cool, wet conditions (around 18–26°C) and spreads via wind-borne spores. Management includes planting blight-resistant varieties, improving drainage, avoiding overhead watering, and using fungicides or copper-based sprays for control.

Leaf Mold

Fig: Leaf Mold Tomato leaf mold is a fungal disease caused by the pathogen Passalora fulva (previously Cladosporium fulvum), which appears as pale-yellow spots on the upper side of leaves and olive green to purple, velvety mold on the underside. It spreads in warm, humid conditions and can lead to leaf yellowing, curling, premature dropping, and even affect fruit, resulting in significant yield loss. Prevention is key and involves managing humidity, practicing good sanitation, and using resistant varieties, while control can include sprays like baking soda to alter leaf pH.

Early Blight

Fig: Early blight

Early blight is a common fungal disease of tomatoes caused by Alternaria solani that creates "bullseye" spots on leaves, stems, and fruit. It thrives in warm, humid conditions and can lead to leaf yellowing, defoliation, and reduced fruit yield. Management includes cultural practices like crop rotation, debris removal, and pruning lower leaves, plus chemical treatments like fungicides, as outlined.

IV. CONCLUSION

The proposed system for Plant Disease Identification Using IoT and AI was designed and analyzed theoretically to evaluate its expected performance and advantages in smart agriculture. The system's functionality was examined in terms of data collection, processing, and disease identification accuracy.

The IoT-based sensing unit continuously collects environmental parameters such as temperature, humidity, and soil moisture from the agricultural field. The theoretical outcome suggests that maintaining an ideal range of these parameters helps in reducing the likelihood of disease spread.

The sensors transmit the collected data to the cloud server through the Wi-Fi or GSM module. The data is visualized in real time on an IoT dashboard, allowing users to monitor environmental changes that could lead to disease formation.