iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: XI Month of publication: November 2025

DOI: https://doi.org/10.22214/ijraset.2025.75534

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue XI Nov 2025- Available at www.ijraset.com

Smart Spraying Rover

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Abstract: The Smart Spraying Rover is an autonomous agricultural vehicle designed to optimize pesticide and fertilizer application through intelligent sensing and control. Traditional spraying methods often result in excessive chemical use, uneven coverage, and environmental pollution. This project aims to overcome these challenges by integrating IoT, machine vision, and automation technologies into a compact rover system.
Keywords: Microcontroller ESP8266, Camera Module ESP32, Ultrasonic Sensor, Wi-Fi, DC Motor, Spraying Pump, IR Sensor, Image Processing

I. INTRODUCTION

The Smart Pesticide Spraying Rover is a cutting-edge autonomous vehicle designed for precision agriculture. Its primary function is to identify and apply pesticides exclusively to plant leaves infected by disease. This high level of specificity is achieved by integrating a camera-based disease detection system with an NFC/RFID Indoor Positioning System (IPS), all orchestrated by an ESP8266 main controller. The core objective is to move agricultural practices toward a more sustainable, data-driven, and resource-efficient model.

The core objectives are:

1) To design and construct an autonomous rover platform for crop field navigation.
2) To implement a real-time, on-device Machine Learning model (Edge Impulse) for precise detection of infected leaves.
3) To develop a control system (NodeMCU ESP8266) that triggers a targeted spray mechanism immediately upon disease detection
4) To establish Wi-Fi communication (NodeMCU ESP8266) to transmit operational telemetry, spray logs, and detection data to a monitoring computer.
5) To validate the system's ability to significantly reduce pesticide usage compared to blanket spraying methods

II. LITERATURE SURVEY

Various researchers have contributed to the field of assistive technology. Rivitti, F., Sanduleanu, D., & Sciaky, J. (2025). Embedded AI for Real-Time Leaf Disease Detection. Sharma. P. Gupta.A (2022) Early Detection of Grapes Diseases UsingMachine Learning and IoT Suyash S. Patil1,Sandeep A. Thorat21, 2 Department of Computer Science Engineering Rajarambapu Institute of Technology, Rajaramnagar Islampur, Sangli (MS) 415409 Drone Technology Enabled Leaf Disease Detection and Analysis system for Agriculture ApplicationsLakshmi Narayana Thalluri, Sai Divya Adapa, Priyanka D, Sri Nithya N, Yasmeen, Addepalli V S Y Narayana Sarma, Srikhakolanu Naga Venkat Identification of plant .

III. METHODOLOGY

The methodology for the Smart Spraying Rover involves a sequence of integrated hardware and software processes that enable autonomous navigation, target detection, and precision spraying. The system works in five major stages: initialization, navigation, image processing, decision-making, and selective spraying.

A. Navigation and Movement Control (RFID-based IPS)

The rover's navigation is entirely dependent on the RFID-based Indoor Positioning System (IPS), enabling precise maneuvering within crop rows.

1) Path Definition: Passive RFID tags are strategically placed at key points along the rover's route, specifically at the beginning and end of each row where a turn is required. Each tag stores a unique location address (e.g., "End-Row-A," "Start-Row-B")
2) Sensing: An on-board RFID reader/scanner is mounted on the rover chassis. As the rover moves, the reader constantly scans for the presence of a tag.

3) Decision Making:If NO tag is detected, the rover continues straight, maintaining constant motor speed via Pulse Width Modulation (PWM) signals to the DC gear motors. If a TURN-POINT tag is detected (e.g., "End-Row-X"), the MCU triggers the
4) Turn Sequence.Actuation (Turn Sequence): The MCU sends precise control signals to the H-Bridge motor driver (e.g., L298N) to stop the forward motion, execute a programmed 180-degree turn (e.g., by driving one side forward and the other backward), and then resume straight path motion into the next row.

B. AI for Disease Detection (Edge Impulse)

The system uses TinyML to classify crop health in real-time right on the edge device, minimizing Embedded latency.

1) Data Acquisition and Training (Offline): A dataset of plant images (Healthy vs. Diseased) is collected, labeled, and uploaded to the Edge Impulse platform.
2) Model Selection and Optimization: A lightweight Convolutional Neural Network (CNN) model (e.g., a variant of MobileNetV2) is trained and optimized for low latency and small memory footprint, suitable for the ESP32-CAM.
3) Deployment (On-Device Inference): The optimized model is converted into a TensorFlow Lite Micro file and flashed directly onto the ESP32-CAM.
4) Real-time Inference: The ESP32-CAM continuously captures images of the crop canopy. The on-board model processes the image and returns a classification result: 'Healthy' or 'Diseased'.

C. Targeted Spraying and IoT Integration

The system ensures that pesticides are only applied to the identified diseased plants, and the data is transmitted wirelessly.

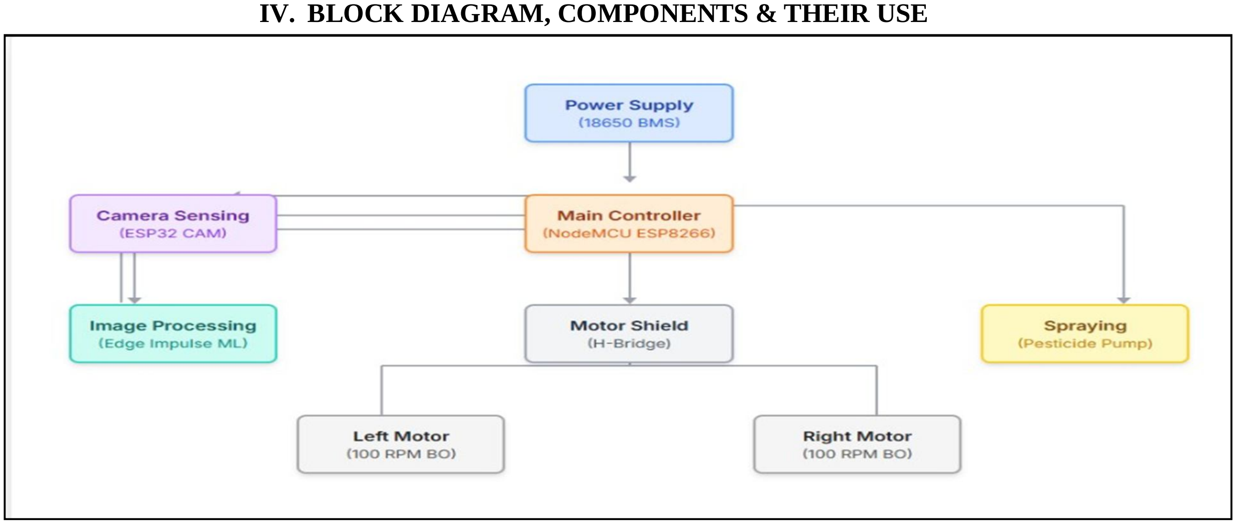
1) Targeted Spraying: The ESP32-CAM sends the inference result ('Diseased') to the main MCU via serial communication (or an equivalent protocol).Upon receiving a 'Diseased' signal, the MCU activates the spraying mechanism (a small DC pump and nozzle) for a pre-determined duration while the rover continues moving, ensuring only the target area is sprayed.
2) IoT Data Transmission (Data-to-Computer):The MCU, utilizing its built-in Wi-Fi capabilities (NodeMCU/ESP32), compiles critical operational data:

- Current Location ID (from RFID scan).
- Time of Spraying.
- Disease Detected (AI result).

This data is transmitted via MQTT or HTTP POST requests to an external cloud platform (e.g., Firebase Firestore or ThingSpeak), fulfilling the requirement to "send data to the computer" for remote monitoring and reporting.

3) Remote Monitoring Interface: A simple web application or dashboard (on the computer) retrieves and visualizes the data from the cloud, showing the rover's last known location and a log of all spraying actions.

IV. BLOCK DIAGRAM, COMPONENTS & THEIR USE



Component	Function
NodeMCU (ESP8266)	Main controller that processes inputs from switches and sensors, and communicates with external modules (GPS, Wi-Fi, Voice).
Edge AI Processor	Requires integrated camera and sufficient processing power for TinyML model inference..
Motor Driver	Dual H-bridge to control two DC gear motors for forward/reverse motion and turns.
Locomotion	Provides necessary torque and speed for rover movement.
Wi-Fi Module (inbuilt in NodeMCU)	Transmits collected data (like location or emergency alerts) to the cloud or mobile app.
Indoor Positioning	Low-frequency reader to detect passive tags at short range for precise stop/turn point.
Spraying Mechanism	Low-power pump to deliver pesticide only upon disease detection.
Power Supply	Must provide stable, sustained power for all components during operation.

V. HARDWARE AND SOFTWARE REQUIREMENT

A. *Hardware Implementation*

1) Microcontroller (Arduino/ESP32)
2) Ultrasonic Sensor
3) Camera Module
4) Image Processing
5) Wi-Fi
6) Power Supply and Battery

B. *Software Implementation*

7) Arduino IDE
8) Embedded C / C++
9) Edge Impulse
10) Cloud Service/IoT

VI. ALGORITHM

1) Step 1: Start
2) Step 2: Initialize modules (Sensors,Motor driver,pump,Microcontroller/processor)
3) Step 3: Begin rover movement
4) Step 4. Capture Image
5) Step 5: Preprocess Image
6) Step 6: Decision Making
7) Step 7: End

VII. CONCLUSION

Autonomous Precision Sprayer Rover using RFID and Embedded AI can be achieved successfully. The core components, including the custom RFID-based navigation for indoor positioning, the deployment of a low-latency TinyML model on the ESP32-CAM for real-time disease detection, and the IoT data transmission capabilities, have been analyzed and selected. The resulting system promises to deliver a practical, economical, and precise solution to modern agricultural challenges by minimizing pesticide usage, maximizing operational safety, and providing actionable data to the farmer**.**

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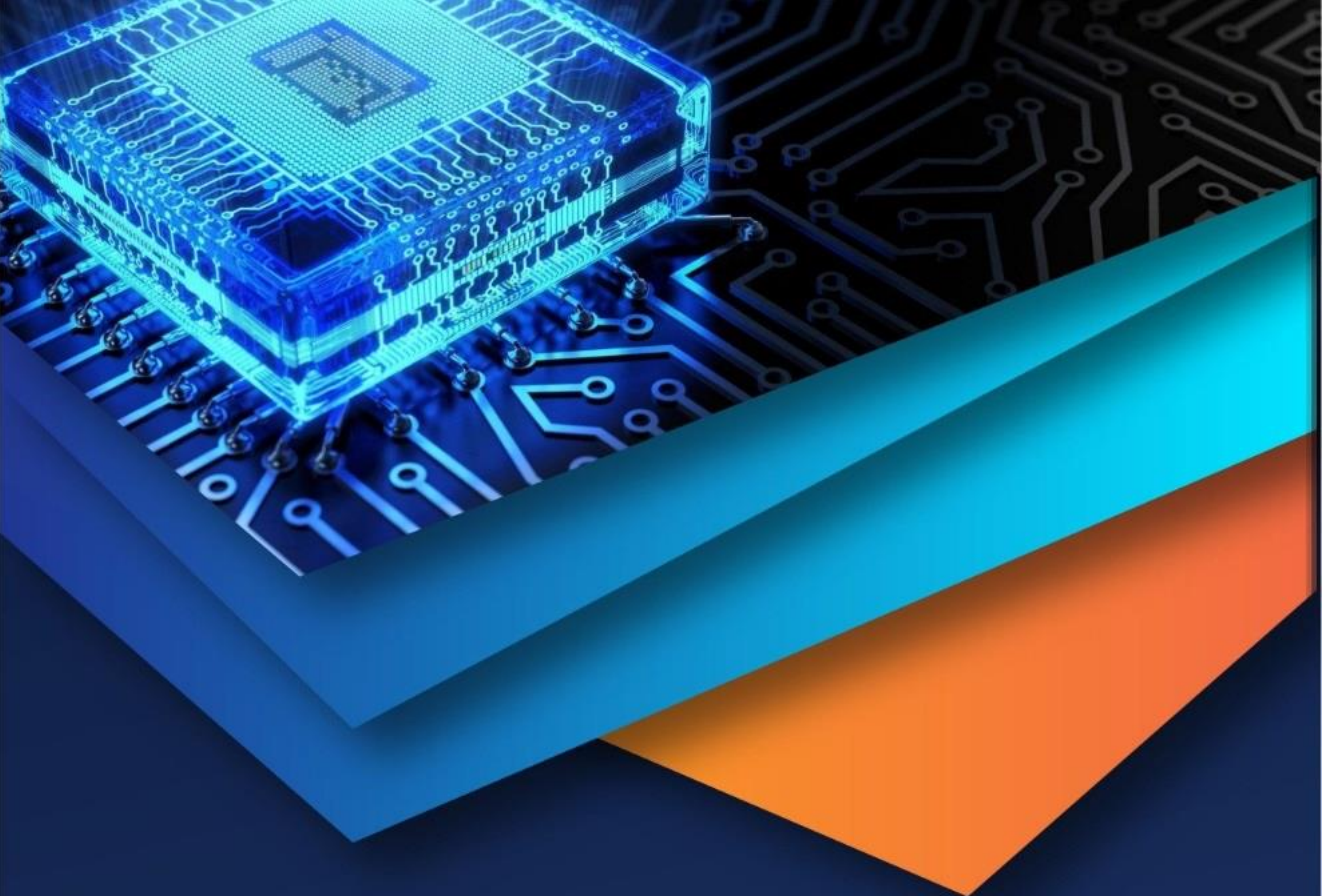
REFERENCES

[1] https://www.researchgate.net/publication/381030590_Agricultural_Pesticide_Spraying_Robot
[2] https://www.hackster.io/538517/embedded-ai-for-real-time-leaf-disease-detection-c9ca46
[3] https://ijariie.com/AdminUploadPdf/Smart_Pesticide_Sprayer_Robot_Using_IOT__In__Agriculture_Field_ijariie26703.pdf
[4] https://www.researchgate.net/publication/395019790_Applying_computer_vision_and_predictive_analytics_to_optimize_water_use_reduce_pesticide_application_and_increase_crop_yield_sustainably
[5] https://www.researchgate.net/publication/224146356_Working_and_Analysis_of_the_H_Bridge_Motor_Driver_Circuit_Designed_for_Wheeled_Mobile_Robots
[6] https://www.researchgate.net/publication/371408123_IOT_Enabled_Pesticide_Sprayer_Robot
[7] https://circuitdigest.com/microcontroller-projects/object-recognition-using-esp32-cam-and-edge-impulse



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