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Automated Pesticide Sprayer using Smart Agribot

Dr. Ganapathi V Sagar, Nirmala Bai L, Sreelakshmi G, Shreyas S, Chandu K T, Hithaishi H K.

Head the Department, Dr Ambedkar Institute of Technology, Bengaluru, Karnataka, India

Associate Professor, Dr Ambedkar Institute of Technology, Bengaluru, Karnataka, India

U.G. Student, Dr Ambedkar Institute of Technology, Bengaluru, Karnataka, India

U.G. Student, Dr Ambedkar Institute of Technology, Bengaluru, Karnataka, India

U.G. Student, Dr Ambedkar Institute of Technology, Bengaluru, Karnataka, India

U.G. Student, Dr Ambedkar Institute of Technology, Bengaluru, Karnataka, India

ABSTRACT: This project presents a multifunctional autonomous pesticide spraying robot designed to improve agricultural productivity through automation. The system uses a Raspberry Pi as the main controller with a camera module for real-time image processing. CNN is used for accurate crop disease detection and fertilizer recommendation. YOLO (You Only Look Once) enables efficient weed detection, which is removed using a DC motor-driven weed cutting mechanism with blades. The robot navigates the field using DC motors and a motor driver. A relay-controlled spraying system ensures precise pesticide application only when required. Ultrasonic sensors and camera-based obstacle detection allow safe and continuous operation. The system reduces manual labour and improves farmer safety by limiting pesticide exposure. Its cost-effective and modular design suits small and medium-scale farmers. Future upgrades include advanced AI-based navigation and crop health data analytics.

KEYWORDS: Autonomous Agricultural Robot, Raspberry Pi, Convolutional Neural Network (CNN), YOLO (You Only Look Once), Precision Agriculture

I. INTRODUCTION

AUTOMATED PESTICIDE SPRAYER USING SMART AGGRIBOT In recent years, agriculture has increasingly demanded modern and sustainable solutions to improve crop yield while reducing labour dependency and environmental impact. Manual pesticide spraying remains a major issue, as it exposes farmers to harmful chemicals and often results in inefficient and excessive pesticide use. These traditional methods are time-consuming, physically strenuous, and prone to chemical wastage. To address these challenges, smart agricultural robots provide a safer and more efficient alternative. The “Automated Pesticide Sprayer Using Smart Agri Bot” focuses on automating pesticide spraying through a remote-controlled robotic system. This agribot ensures uniform pesticide application while significantly reducing human involvement. It is controlled using a smartphone application via Bluetooth technology, improving safety and ease of operation. By eliminating direct human contact with pesticides, the system enhances farmer health and operational safety. The core hardware includes an Arduino Uno microcontroller and an L293D motor driver module. A DC motor-driven spraying mechanism with a multi-nozzle arm enables wide-area and uniform coverage. A Raspberry Pi 3 processor is used for image processing and machine learning operations. Python-based machine learning models analyze crop images to detect plant diseases accurately.

II. LITERATURE SURVEY

1. Embedded Design of Automatic Pesticide Spraying Robot Control System [1] In the paper titled “Embedded Design of Automatic Pesticide Spraying Robot Control System”, Ahamed Mustak, Hongbin Ma, Leegue Song, and Yuejun investigate the development of an intelligent pesticide spraying mechanism utilizing a fuzzy PID controller. The research focuses on achieving precise variable pesticide application by integrating a PLC-based spraying flow control mechanism. This dual-layered control strategy allows for dynamic adjustment of pesticide flow based on real-time field conditions. The system is evaluated for its efficiency in controlling overshoot, achieving precise control with overshoot values limited to 10.76% and 7.17% respectively. This study significantly contributes to the domain of automated pesticide application by combining advanced control theory with practical embedded implementation, ultimately improving yield consistency while minimizing chemical waste.

2. Design and Development of Autonomous Pesticide Sprayer Robot for Fertigation Farm [2] The study titled “Design and Development of Autonomous Pesticide Sprayer Robot for Fertigation Farm” by A.M. Kassim, M.F.N.M. Temeeai, A.K.R.A. Jayam, and A.H. Azahar presents the creation of a mobile robotic platform specifically designed for pesticide spraying in fertigation based agricultural systems. The authors propose an autonomous solution that integrates multiple sensors and automation technologies to reduce manual involvement in hazardous spraying tasks. The robot is capable of navigating farm terrains and systematically applying pesticides with high precision. Experimental results highlight a reduction in insect-related crop damage and a measurable improvement in yield quality. This research reinforces the role of automation in enhancing both safety and productivity in modern farming, especially within intensive cultivation environments.

3. Agriculture Robot – A Pesticide Spraying Device [3] P. Rajesh Kanna and R. Vikram, in their work “Agricultural Robot – A Pesticide Spraying Device”, design a robotic system focused on selective pesticide application. The robot is engineered to control spraying distance and volume to ensure optimal pesticide distribution while avoiding excess use. The study emphasizes environmental responsibility and user safety by reducing chemical exposure to humans. The implementation of this system demonstrates that targeted spraying not only conserves resources but also minimizes ecological impact. The research addresses challenges related to accurate targeting and spatial management in robotic agriculture, offering a viable solution for precision pest control.

4. Automated Pesticide Sprayer for Agricultural purpose [4] Shalini D. V., in her paper “Automatic Pesticide Sprayer for Agriculture Purpose”, proposes a simplified and effective spraying robot aimed at open-field applications. The system is engineered to ensure consistent pesticide coverage while significantly reducing manual labor requirements. The robot is programmed to operate in various field conditions, allowing for timely and uniform spraying without human supervision. This research highlights the potential of automation in enhancing agricultural productivity and efficiency, especially in rural areas where labor shortages are common. The emphasis on ease of use and coverage optimization makes the system suitable for widespread adoption in small to mid-sized farms.

5. Fabrication of Automatic Pesticide Spraying Machine [5] Dhiraj N. Kumbhare, Vishal Singh, and Prashik Waghmare, in their research “Fabrication of Automatic Pesticides Spraying Machine”, focus on building a practical and time-saving spraying solution to reduce human contact with harmful chemicals. The automated machine is designed for uniform pesticide distribution, enhancing coverage accuracy and operational efficiency. The authors emphasize the system’s ability to save time, reduce manual effort, and improve farmer safety. Their work underlines the importance of accessible automation in agriculture and showcases the benefits of integrating low-cost hardware solutions into pesticide spraying applications.

III. METHODOLOGY

The working of the pesticide spraying robot is illustrated in the above block diagram. The system is primarily controlled using a smartphone, which connects wirelessly to the robot via a Bluetooth module. When the user sends directional or control commands through the smartphone application, these are received by the Bluetooth module and transmitted to the Raspberry pi microcontroller. The Arduino acts as the central processing unit, coordinating both movement and spraying actions.

The Raspberry pi receives power from the power supply and interprets the control signals received via Bluetooth. Based on the input commands, the Raspberry pi sends appropriate signals to two key modules. The Driver Modem, which controls the Prototype Car Module (i.e., the robot's wheels or locomotion system), allowing the robot to move forward, backward, or turn. The Driver Module that is connected to the Pesticide Sprayer, which controls the operation of the spraying mechanism. Upon receiving commands, the Raspberry pi interfaces with two modules: the driver modem and the driver module.

The driver modem controls the prototype car module, which enables the robot to move across the agricultural field. Based on directional inputs, the robot can move forward, backward, or make turns. Simultaneously, the driver module is responsible for activating the pesticide sprayer. When spraying is required, the Arduino sends a signal to the driver module, which powers the pesticide pump or motor to begin spraying. The entire system is powered by a central power supply, which delivers regulated voltage to all components including the Raspberry pi, motors, Bluetooth module, and sprayer.

This integrated approach allows the robot to operate efficiently in field conditions.

By using wireless control, automated spraying, and motor-driven navigation, the system significantly minimizes manual labor and reduces the risk of human exposure to harmful chemicals. Overall, this setup offers a reliable, cost-effective, and user-friendly solution for modern precision farming. When the robot reaches the designated area in the field, the Arduino activates the sprayer through the driver circuit.

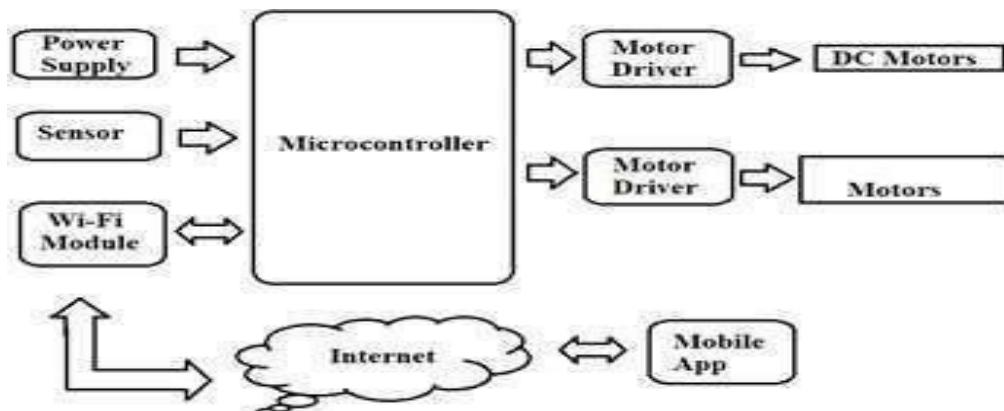


Fig. Block Diagram

IV. EXPERIMENTAL RESULTS

The V. RESULTS developed Autonomous and Remotely The implementation and testing of the "Automated Pesticide Sprayer Using Smart Agri Bot" yielded several crucial positive results, confirming the project's success in meeting its core objectives. The wireless control system, utilizing Bluetooth and the mobile application, demonstrated high reliability and ease of use, successfully eliminating the need for farmers to enter the field during spraying operations. This directly achieved the primary safety goal by guaranteeing zero direct human exposure to harmful chemicals. Crucially, the integration of the Raspberry Pi 3 and machine learning algorithms proved effective in accurately identifying plant diseases from captured images. This capability led to a fundamental shift from traditional blanket spraying to targeted pesticide application, resulting in a significant reduction in the overall volume of pesticides consumed. The system thus confirms its potential for substantial cost savings and reduced environmental impact. Furthermore, the mechanical design, incorporating a multi nozzle arm and adjustable nozzles, ensured uniform and precise spray coverage across the designated farm area, regardless of crop height or density, leading to improved pest control efficacy. The robot's mobile platform successfully navigated various farm terrains, proving its practical applicability. In summary, the project delivered an operational, cost-effective, and safe automated solution that successfully validates the principles of precision agriculture for small and medium-scale farmers.



Fig.1. Model robot



Fig. 2. Hardware components and connections

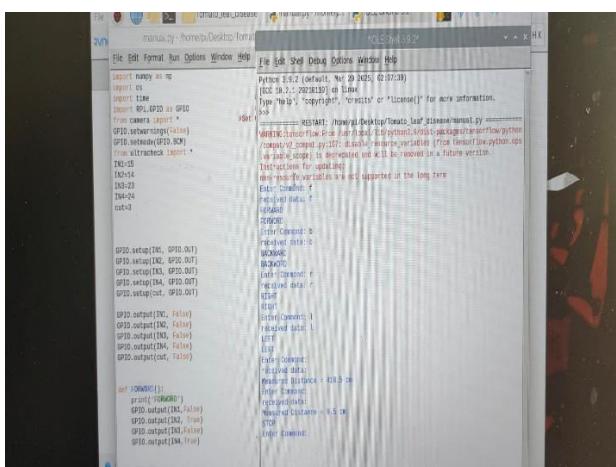


Fig.3. Result 1 – Obstacle detection and collision avoidance

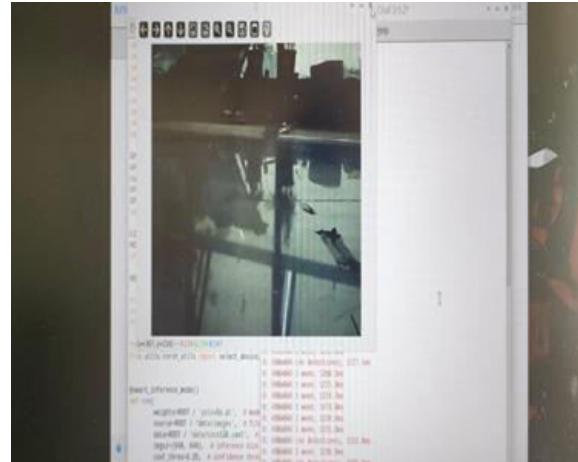


Fig.4. Result 2 - Pesticide

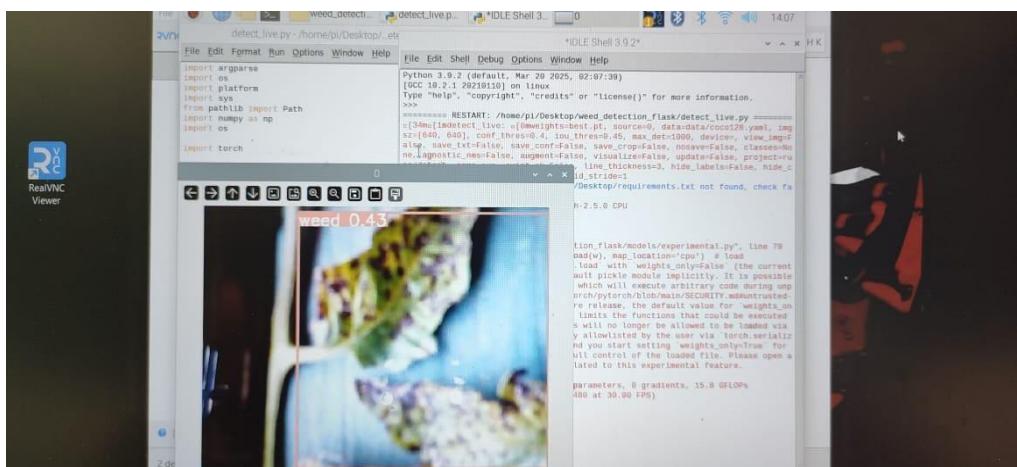


Fig. 5. Result 3 – Plant disease detection

V. CONCLUSION

The development of an automated pesticide sprayer and weed cutting robot demonstrates how modern technology can be successfully integrated into the agricultural sector to increase efficiency, reduce manual labor, and promote sustainable farming practices. By combining Raspberry Pi based control, AI-powered image detection (YOLO, CNN), and smart actuation mechanisms like motorized blades and pumps, the system is capable of accurately identifying weeds, spraying targeted pesticide doses, and performing weed removal with minimal human intervention. Additionally, the incorporation of ultrasonic and IR sensors ensures obstacle detection and safe navigation through farming terrain. This project significantly reduces the health risks associated with manual pesticide spraying and minimizes chemical wastage, making it both economical and eco-friendly. Overall, it contributes to the ongoing transformation of traditional agriculture into a more automated, precise, and intelligent system.

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