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PESTICIDE SPRAYING ROBOT FOR SMART AGRICULTURE

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ABSTRACT
This project presents an innovative solution for automating critical agricultural tasks such as pesticide spraying, fertilizer application, and other field activities. The primary goal is to address the health and safety challenges faced by farmers due to prolonged exposure to harmful chemicals and hazardous environments. By replacing manual intervention with a robotic system, the proposed approach ensures a safer, more efficient, and sustainable method for managing agricultural chores.

Keywords:
Microcontroller-based pesticide spraying robot, Bluetooth-controlled agricultural robot, Soil moisture sensing for smart farming, DC motor and pump-based spraying system, Automation in pesticide application

INTRODUCTION
The adoption of robotics in agriculture has emerged as a transformative approach to improve efficiency, reduce labour dependency, and enhance precision in farm operations. With increasing global food demand and the ongoing shortage of agricultural labour, there is a growing need for intelligent systems that can automate repetitive and hazardous tasks. Among these, the automation of pesticide spraying has gained significant attention due to the health risks involved in manual application and the inefficiencies associated with conventional methods.

Manual pesticide spraying often leads to inconsistent coverage, excessive chemical usage, and direct exposure of workers to toxic substances. These challenges highlight the importance of a reliable and safe alternative that ensures uniform application while minimizing environmental impact. Robotic systems offer a promising solution by delivering controlled spraying, thereby reducing chemical wastage and improving operator safety.

Advancements in embedded electronics, microcontroller programming, and wireless communication have enabled the development of affordable and efficient robotic platforms tailored for agricultural use. These robots are capable of navigating fields, performing targeted tasks, and collecting real-time environmental data. Unlike traditional machinery, which can be bulky and terrain-dependent, robotic systems are more adaptable, compact, and precise in operation. They can function under varied field conditions and support sustainable farming practices by integrating sensor-based automation and data-driven decision-making.

This study presents the design and implementation of a semi-autonomous pesticide spraying robot aimed at supporting small and medium-scale farmers. The robot incorporates a microcontroller for system management, DC motors for movement, a relay-controlled DC pump for spraying liquids, a soil moisture sensor for environmental feedback, and a Bluetooth module for wireless control. The system is designed to be low-cost, user-friendly, and capable of reducing manual labour and chemical exposure in pesticide application.

By introducing this robotic solution, the project contributes toward safer, more efficient, and environmentally conscious agricultural practices. Future enhancements may include the addition of GPS-based navigation, remote monitoring via IoT, and machine learning algorithms to further increase the system's autonomy and adaptability.

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LITERATURE REVIEW

Automation in agriculture has become increasingly important due to labour shortages, health hazards, and the need for higher efficiency in farming practices. One area that has seen significant innovation is the use of robotic systems for pesticide spraying. Traditional methods of pesticide application often involve direct human contact with chemicals, leading to health risks, inconsistent coverage, and unnecessary wastage. To overcome these issues, researchers and engineers have started developing automated systems that can perform spraying tasks with greater precision and safety.

The use of microcontrollers in agricultural robotics has enabled more accurate control of operations such as movement, spraying, and data collection. These systems allow the robot to follow pre-defined commands or user inputs, ensuring that pesticides are applied evenly and only where necessary. Additionally, advances in embedded system programming have made it possible to integrate multiple components such as motors, sensors, pumps, and relays into a single, compact robot.

Wireless communication technologies like Bluetooth have further enhanced these robots by allowing remote operation. This feature not only improves safety but also makes it easier for farmers to control the robot in the field without physical contact. The inclusion of soil moisture sensors and other environmental monitoring tools adds an intelligent layer to the system, allowing decisions to be made based on real-time data. This helps optimize the use of pesticides and conserve resources.

In recent years, developments in smart agriculture have also incorporated Internet of Things (IoT) and artificial intelligence (AI) to allow for real-time monitoring and autonomous decision-making. These technologies make it possible to collect data from multiple sources and adjust spraying activities accordingly, enhancing both precision and effectiveness.

Practical implementations of pesticide-spraying robots are often designed to be low-cost and user-friendly, making them suitable for small and medium-scale farms. The overall goal of these systems is to reduce labor dependency, improve safety, and support sustainable farming practices through targeted pesticide application.

OBJECTIVES

This project aims to develop a low-cost, semi-autonomous robot for pesticide spraying in agricultural fields, with the primary goal of reducing direct human exposure to harmful chemicals. The robot operates using a microcontroller that controls its movement and spraying functions with precision, ensuring efficient and targeted pesticide application.

Bluetooth connectivity enables wireless remote operation via smartphone, allowing users to control the robot from a safe distance. A soil moisture sensor is integrated to support intelligent spraying decisions, reducing unnecessary usage of chemicals and promoting sustainable farming.

The system is powered by a regulated power supply for safe and consistent performance in varying field conditions. Designed to be lightweight, affordable, and easy to maintain, the robot is especially suited for small and medium-scale farmers.

Additional objectives include minimizing environmental pollution, conserving resources, improving farm productivity, and creating a scalable platform for future enhancements such as GPS navigation, AI integration, and real-time monitoring.

By combining automation with practical design, this project seeks to offer an accessible solution for advancing precision agriculture in resource-constrained settings.

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METHODOLOGY

The development of the smart pesticide spraying robot followed a structured approach involving both hardware integration and embedded programming. The robotic system was assembled using key components including a microcontroller (such as Arduino UNO), DC motors for movement, a pesticide spray pump, a Bluetooth communication module, a relay switch, and a soil moisture sensor. These components were mounted onto a compact, four-wheeled mobile chassis designed for basic field navigation.

The microcontroller served as the central control unit, programmed using embedded C/C++ to coordinate the movement of the robot and regulate the pesticide spraying mechanism. The DC motors were interfaced through a motor driver circuit, enabling forward, backward, and directional movement. The Bluetooth module facilitated

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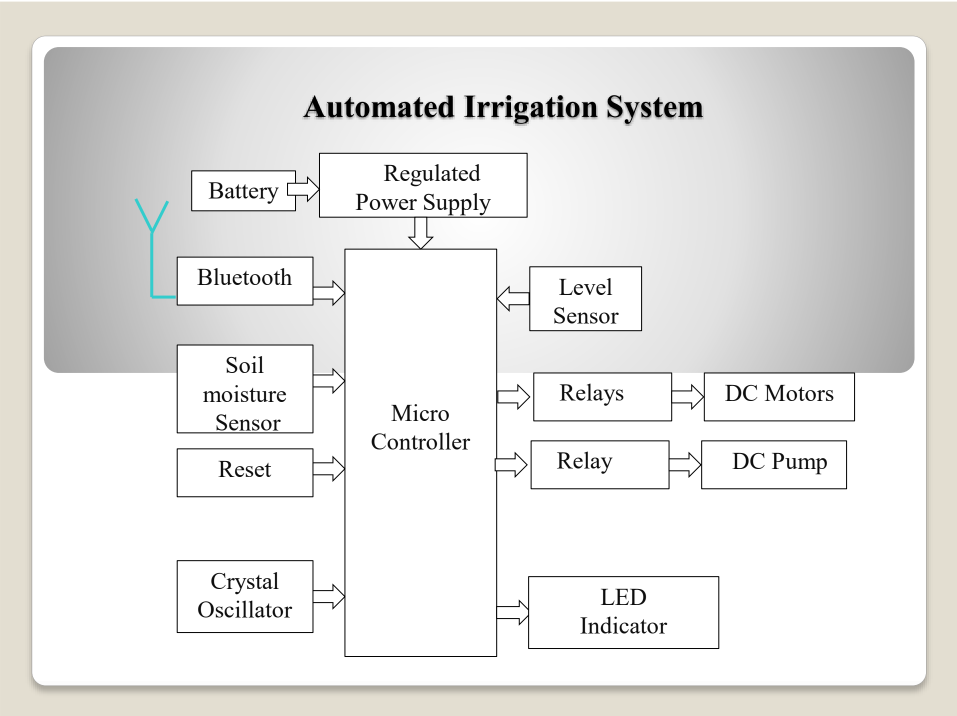
wireless communication between the robot and a mobile device, allowing the user to send control commands remotely through an application or serial interface.
A relay module was connected to the microcontroller to control the pesticide pump, enabling automated switching based on user commands or sensor input. The soil moisture sensor was deployed to gather real-time environmental data, particularly soil humidity levels, which informed decisions on whether spraying was necessary in a particular area, thereby conserving chemicals and reducing excess spraying.
The robot was powered through a regulated DC power supply to ensure voltage stability and protect sensitive components from fluctuations. All electrical connections were carefully insulated and tested to prevent short circuits and ensure reliable operation under field-like conditions.
Once assembled, the complete system underwent functional testing in controlled environments to evaluate its movement precision, response time to Bluetooth commands, reliability of spray activation, and consistency in data collection by the soil moisture sensor. Calibration of the spraying mechanism was also performed to ensure uniform coverage and appropriate flow rate.



Block Diagram of Irrigation System

The main blocks of this project are:
1. Micro controller
2. Reset
3. Crystal oscillator
4. Relay
5. Regulated power supply (RPS)
6. LED Indicator
7. Bluetooth
8. DC Motor
9. Soil moisture
10. DC PUMP

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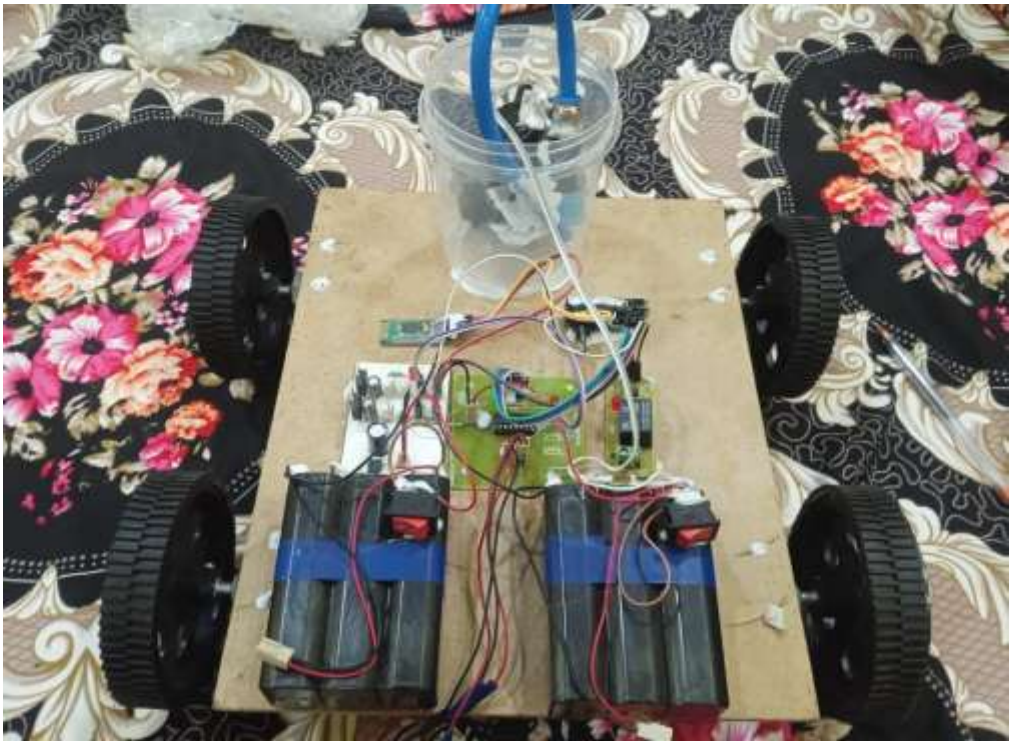

RESULTS AND DISCUSSION

The developed robot successfully performed basic pesticide spraying operations under remote control. Using Bluetooth communication, the robot could be easily navigated through test fields, and the spraying system responded accurately to user commands. The DC motors provided smooth movement on flat terrain, and the DC pump efficiently sprayed the liquid pesticide. The soil moisture sensor gave consistent readings, which can help in optimizing spraying based on soil conditions in future upgrades.

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CONCLUSION

The Agricultural Pesticide Spraying Robot is an innovative solution that enhances efficiency, precision, and safety in farming. By automating the pesticide spraying process, it reduces labor costs, minimizes chemical waste, and protects farmers from harmful exposure. With features like IoT-based control, obstacle detection, and precision spraying, this robot makes farming smarter and more sustainable.
As technology advances, AI, GPS, and solar power integration will further improve its capabilities, making it a key tool for the future of precision agriculture. This project paves the way for eco-friendly and cost-effective farming practices, ensuring higher crop yields and a healthier environment.

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