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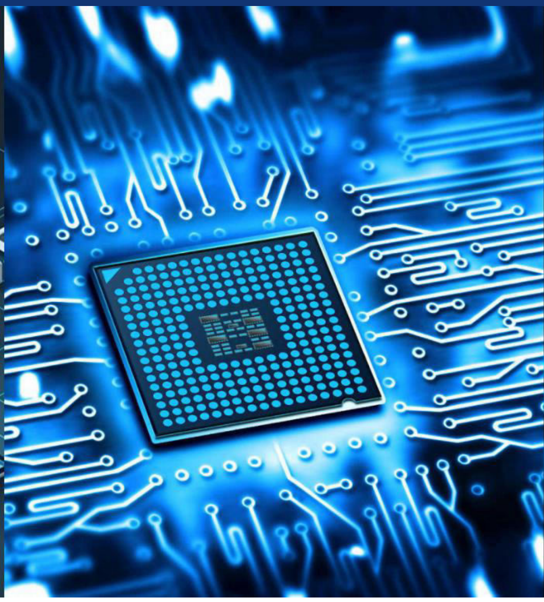

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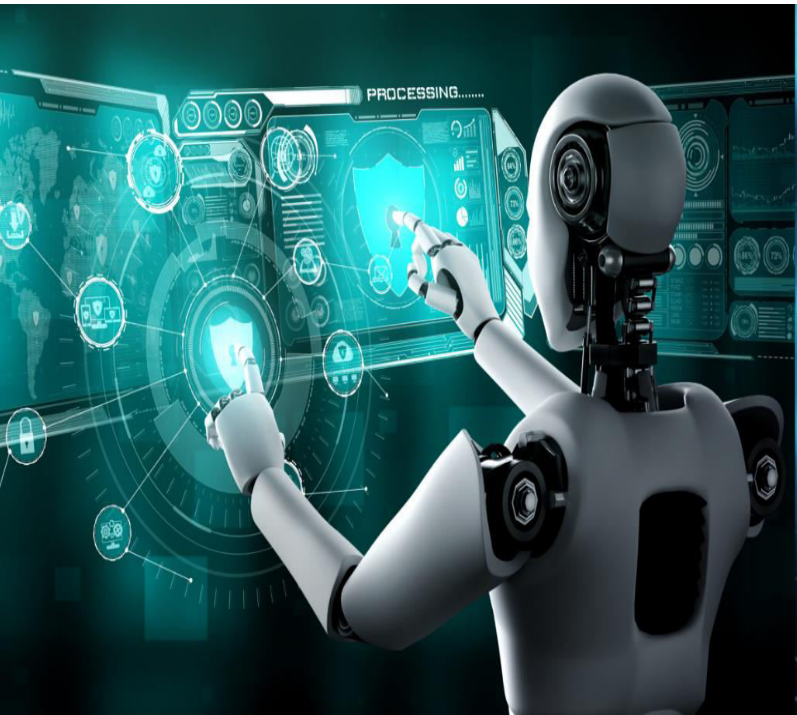

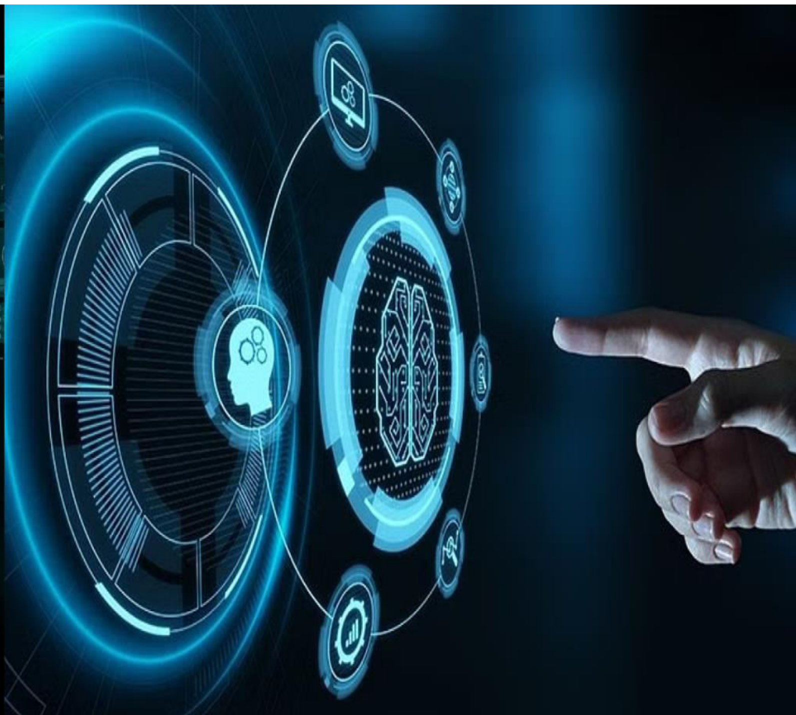

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Smart Spraying Robot

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ABSTRACT: This paper discusses the design and development of a Smart Spraying Robot aimed at enhancing efficiency and safety in the application of agricultural pesticides. Agriculture is vital for maintaining the global food supply, yet traditional pesticide spraying methods pose significant health risks to farmers due to their direct exposure to harmful chemicals. Moreover, manual spraying often leads to uneven pesticide distribution, resulting in overuse, crop damage, and environmental pollution. To tackle these issues, this paper introduces a smart agricultural robot equipped with advanced sensors and IOT technology to automate and optimize the spraying process. The Smart Spraying Robot features a moisture sensor, ultrasonic sensors for obstacle detection, and a spray nozzle mechanism controlled by an Arduino Nano microcontroller and an ESP8266 Wi-Fi module. It can navigate autonomously in the field and can also be operated remotely via a smartphone application, allowing farmers to manage the system without being physically present. The moisture sensor ensures that pesticides are applied only when necessary, minimizing chemical waste and protecting the environment. Its modular design, powered by solar energy and battery backup, enhances energy efficiency and adaptability to various agricultural conditions. By integrating automation technologies, the robot reduces the need for human intervention, thereby lowering labour costs and exposure to hazardous chemicals. The use of affordable components ensures that the system is accessible to small and medium-scale farmers. By adopting this Smart Spraying Robot, farmers can achieve more accurate pesticide application, enhance crop health, and promote sustainable agricultural practices. This paper underscores the potential of IOT and automation in revolutionizing modern agriculture while advocating for eco-friendly farming solutions for the future.

KEYWORDS: IOT, Pesticide Control, Precision Farming, Obstacle Detection, Moisture Sensing, Arduino, ESP8266.

I. INTRODUCTION

A.Overview:
The Smart Spraying Robot has been designed to improve efficiency, safety, and accuracy in the application of pesticides in agriculture. Conventional methods of pesticide spraying put farmers at risk of exposure to harmful chemicals, which can lead to health problems like skin irritation, respiratory issues, and chronic illnesses. Additionally, manual spraying often results in excessive pesticide use, potentially harming crops, raising costs, and contributing to environmental pollution. To tackle these issues, the Smart Spraying Robot utilizes automation and IOT technologies to minimize human exposure and enhance the effectiveness of pesticide application.

B. **Proposed system functions**:
This project focuses on creating a Smart Spraying Robot that utilizes IOT technology for efficient pesticide application in agriculture. The robot is designed to navigate autonomously through fields, monitoring soil moisture levels and avoiding obstacles with the help of various sensors. Users can control and monitor the system remotely via an IOT application, which promotes effective pesticide usage while minimizing human exposure.

C**. Components:**
• Arduino Nano microcontroller.
• ESP8266 Wi-Fi module for IOT connectivity.

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• Moisture sensor module for monitoring soil conditions.
• Ultrasonic sensor for detecting obstacles.
• Solar panel to provide a sustainable power source.
• DC motors and motor driver module for movement.
• Water pump and spray nozzle for applying pesticides.

D. Advantages of Smart Spraying Robot:

1. Reduced Human Exposure: By automating the spraying process, the need for direct human involvement is significantly decreased, which helps to minimize health risks associated with pesticide inhalation or skin contact.
2. Precision Spraying: The built-in moisture sensor accurately measures soil moisture levels, ensuring that pesticides are applied only when necessary. This approach not only prevents excessive chemical use but also promotes better crop health.
3. Cost Efficiency: The robot optimizes pesticide usage, which helps to prevent waste and reduces the overall amount of chemicals required. Furthermore, automation contributes to lower operational costs, including labour and fuel expenses.
4. Environmental Protection: With targeted spraying, the robot minimizes pesticide runoff into nearby water sources, which helps to reduce soil and water contamination and supports healthier ecosystems.
5. Energy Efficiency: The robot is equipped with a solar panel and battery backup, allowing it to utilize renewable energy. This feature reduces dependence on non-renewable power sources and promotes sustainable farming practices.
6. Remote Control: Thanks to the ESP8266 Wi-Fi module, farmers can control the robot via their smartphones, enabling them to manage and monitor its operations from a distance, which enhances convenience and operational flexibility.

II. SYSTEM ANALYSIS

A. Problem Definition:
Agricultural pesticide spraying methods encounter various challenges, such as inefficient application, health risks for farmers, and labour-intensive processes. This research aims to design and implement a smart pesticide spraying robot utilizing IOT technology to automate and optimize pesticide usage in agricultural fields. The key challenges this smart spraying robot seeks to tackle include: -

Health Risks: Manual pesticide spraying puts farmers at risk of exposure to harmful chemicals, leading to serious health issues like skin conditions and respiratory problems. Automating this process will reduce human contact with pesticides.

Pesticide Efficiency: Existing spraying methods frequently result in either over-application or under-application, causing environmental damage and decreased crop yields. The robot will incorporate soil moisture sensors and precise spraying mechanisms to enhance pesticide efficiency.

Labour Intensity: The manual application of pesticides is both labour-intensive and time-consuming. The smart robot is designed to lessen labour demands by automating the spraying process.

Field Challenges: Agricultural fields often have obstacles like uneven terrain and varying plant growth patterns. The robot will be equipped with obstacle detection sensors to navigate these fields effectively. This problem definition emphasizes enhancing the safety, efficiency, and cost-effectiveness of pesticide application while also reducing environmental impact and labour intensity.

B. Implementation:
In this project for a smart spraying robot, we utilized an Arduino Nano to create the necessary circuits. The spraying mechanism features an ultrasonic sensor, a moisture sensor, and a water pump, all connected to the Arduino Nano for automated pesticide application. The moisture sensor monitors soil moisture levels and activates the water pump when moisture falls below a set threshold. To enable remote monitoring and control, we incorporated an ESP8266 module for Wi-Fi connectivity. A servo motor is used to adjust the spray nozzle's direction, ensuring precise application. The robot

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is powered by a combination of a solar panel and a battery system, promoting sustainability. For obstacle detection, we employed an HC-SR04 ultrasonic sensor, which halts the robot's movement upon detecting an obstacle to prevent collisions. The motor driver module manages the movement of the DC motors, allowing for smooth navigation throughout the field. This comprehensive system guarantees efficient and automated pesticide spraying while reducing human exposure.

C. Circuit Design:

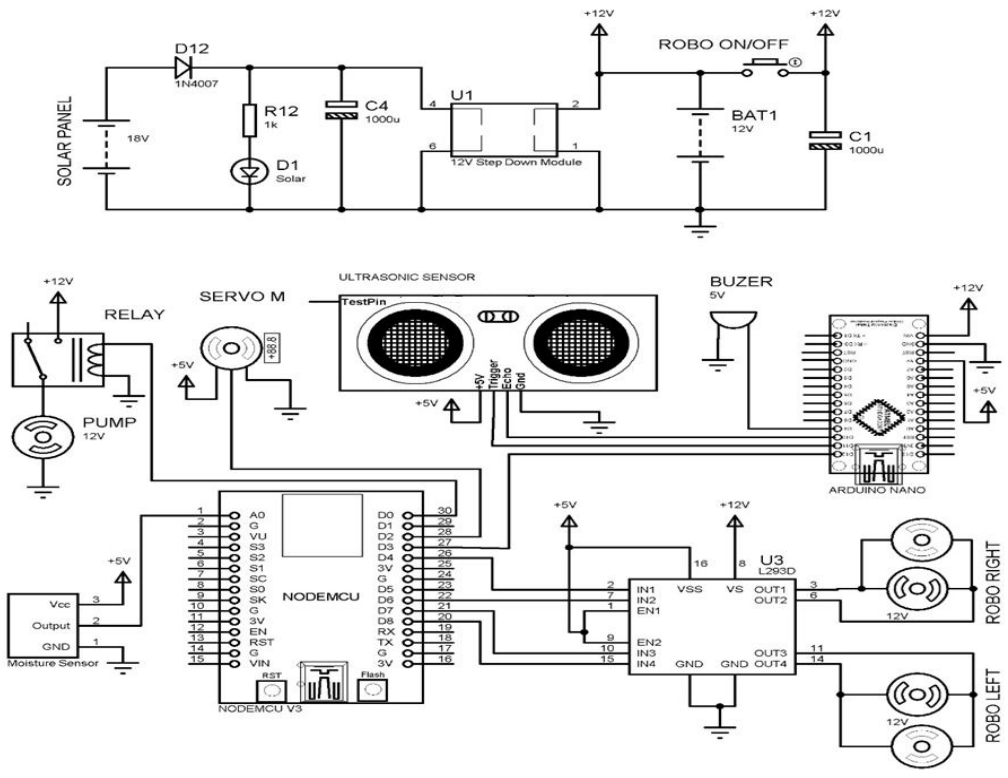

Fig1. diagram of smart spraying robot

- •The solar panel charges a 12V battery via a step-down module.
- • Arduino Nano manages the ultrasonic sensor (D10, D11), buzzer (D9), and motor driver (D3-D6).
- • Node MCU handles the moisture sensor (A0), relay (D1), servo motor (D2), and water pump.
- • L293D motor driver controls two DC motors for movement.
- • Power is shared with +12V, +5V, and common ground.

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D. Model:

Fig2. Developed Model

III. DISCUSSION

A. Interpretation of Results:

The project description suggests that the smart spraying robot built with Arduino Nano has been successfully implemented. The ultrasonic sensor plays a crucial role in detecting obstacles, allowing the robot to navigate safely through the field. Meanwhile, the moisture sensor keeps track of soil moisture levels, which helps in accurately controlling the pesticide application. The servo motor operates the spray nozzle, ensuring that the pesticide is applied precisely, minimizing waste and maximizing coverage. With the ESP8266 module, the robot can connect to Wi-Fi for remote monitoring and control. Once programmed, the Arduino Nano efficiently manages all components, enabling the system to operate autonomously without needing constant internet access. This consistent design promotes optimal pesticide usage, reduces human exposure, and enhances agricultural productivity.

B. Comparison with Previous Research:

This project distinguishes itself from earlier pesticide sprayers by incorporating IOT technology. The inclusion of remote monitoring and control features offers a more sophisticated and safer alternative compared to traditional manual or semi-automated sprayers.

C. Limitations:

- Currently, the project is mainly centred on pesticide spraying. It does not yet address other aspects of agricultural automation, such as monitoring crop health or distributing fertilizers, which could further improve its effectiveness.
- The time response of the robot may not be sufficiently rapid to be able to avoid sudden obstacles, particularly if moving obstacles, or uneven terrain are present.

D. Suggestions for Future Research:

Future studies could look into how AI can be used to analyse crop health, incorporating sensors to evaluate soil nutrients and improve energy efficiency. Expanding the robot's capabilities to cover a broader range of agricultural tasks could enhance its versatility. Additionally, research might focus on utilizing more sensors for better obstacle detection and optimizing pesticide use. Adopting a solar power system could boost sustainability and reduce dependence on power grids. Integrating advanced data analytics could facilitate real-time monitoring and reporting of pesticide application. Furthermore, investigating modular designs could allow the system to be more adaptable to various crop types and field conditions.

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IV. CONCLUSIONS AND FUTURE WORK

A. CONCLUSION:

The development and testing of the smart spraying robot utilizing IOT technology have proven successful, demonstrating its capability to autonomously spray pesticides while optimizing usage and minimizing human exposure to harmful chemicals. By integrating soil moisture sensors, the robot applies pesticides only when necessary, reducing overuse and supporting environmental sustainability. The addition of obstacle detection technology allows the robot to navigate complex agricultural settings efficiently, avoiding hazards and ensuring thorough field coverage. Overall, this system marks a significant leap in agricultural automation, merging precision, safety, and efficiency, making it an essential tool for contemporary farming practices.

B. FUTURE WORK:

Looking ahead, there are numerous ways to expand and enhance the smart spraying robot. Integrating AI-driven crop health analysis could significantly boost the robot's decision-making abilities, allowing it to recognize specific crop conditions and modify pesticide application accordingly. Adding more sensors, such as pH and nutrient detectors, would enable a more detailed assessment of soil conditions, further refining pesticide usage. Improving the power management system, including the exploration of hybrid energy sources like wind or advanced solar panels, could prolong the robot's operational time. Additionally, the robot's capabilities could be broadened to encompass fertilizer distribution, automated irrigation, and crop monitoring, transforming it into a versatile agricultural tool. Conducting scalability tests in larger fields and with various crop types would help evaluate the robot's performance in different farming contexts. Collaborating with agricultural researchers and farmers can ensure the system is tailored to meet specific regional agricultural needs, promoting wider adoption and long-term success.

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REFERENCES

1.“Effect s of chemical pesticides on human health” Shanghai Journal of Preventive Medicine, vol. 15, no. 8, pp 383-384, 2013.
2.S. H. Deng, Z. Cai, D. D. Fang, H. Liao, G. Mont Avon, “Application of robot offline programming in thermal spraying original research article”, Surface Coatings Technology, vol. 206, no. 19, pp. 3875-3882,2012.
3.N. Dai, “Development and application of Agricultural Robot,” Agricultural Research, vol. 31, no. 2, pp. 241243, 2009.
4.X. Zhao, “The main application of intelligent robot in the field of agriculture automation”, Chinese Agricultural Science Bullet in, vol. 26, no. 10, pp. 360-364, 2010.
5.G. Gao, H. Zhou, and X. Niu, “An intelligent variable spraying decision-making system based on fuzzy neural network for greenhouse mobile robot”, Intelligent Computing for Sustainable Energy and Environment, vol. 355, pp. 257-265, 2013.
6.R. Gadow, A. Candel, and M. Floristán, “Optimized robot trajectory generation for thermal spraying operations and high-quality coatings on freeform surfaces”, Surface Coatings Technology., vol. 205, no.4, pp. 1074-1079, 2010.
7.Linz, A. Ruckelshausen and E. Wunder, "Autonomous Service Robots for Orchards and Vineyards: 3d Simulation Environment of Multi Sensor Based Navigation and Applications"
8.“Design and Fabrication of Organic Fertilizer and Pesticides Sprayer” Dr.S K Choudhary, published in “International Journal for Scientific Research & Development”, Vol.03, ISSN: 2321-0613(2015)
9.“Fabrication of Automatic Pesticides Spraying Machine” Dhiraj N. Kumbhare, published in “International Research Journal of. Engineering and Technology”, Vol.03, ISSN: 2395-0056(2016)
10.“Mechanically Operated Cart for Pesticide Sprayer for Agriculture” Faijubhai Malek, published in “International Journal of Innovative Research in Science, Engineering and Technology”, Vol.05, ISSN: 2319-8753(2016)