

Design & Development of Automatic Pesticide Spraying Machine

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Abstract

We all know that India is a farming country. Agriculture employs over three-quarters of India's population. Now a days in the world, contemporary technology is essential. Farmers cultivate a wide range of crops. Farmers encounter a variety of challenges. There are numerous challenges with farming. Locusts, insects, worms, and other pests' destruction of farms Furthermore, hazardous compounds come into touch with Farmers spray pesticide liquid over their crops. This has negative consequences human health consequences. The objective of this system is to offer the public with a cost-effective and healthy machine farmer. So as to reduce the challenges that farmers have when spraying pesticides, we designed a system that is entirely automated. For the operation, we used a NodeMCU ESP32 Microcontroller. Because this technology is solely Bluetooth based, the farmer's direct physical interaction is reduced. The Bluetooth module incorporated inside the NodeMCU microcontroller set it apart from other microcontrollers such as Arduino and Raspberry Pi. NodeMCU programming is simple and similar to Arduino programming, thus we don't need any other programming language or IDE. This technique saves farmers money and time while also reducing the harmful impacts of pesticides.

Keywords: NodeMCU; Pesticide spraying; Automatic Pesticide spraying; cost - effective spraying, NodeMCU ESP3.

1. Introduction & Literature Review

The world's population has risen to 7.8 billion people. As a result, agricultural product demand has soared. New farming technologies are being introduced to increase and improve product production. We see many tools and machines in our daily lives that are utilized in farming to produce better and higher-quality products. Almost every industry in today's generation is moving towards automation.

Similarly, the agriculture industry is moving toward automation, which is important. Because of the growing population, it is vital to produce high-quality goods. Since the last 50 years, the globe has experienced a significant food scarcity, which has gotten worse in recent years. Crops are damaged by insects, birds, grasshoppers and other pests. Farmers face numerous challenges during farming. Farmers must take necessary care when spraying pesticides on their farms. Spraying pesticides is an important element of our farming operation. We must protect the crops from insects, birds, and other predators. Farmers come into contact with this toxic substance while spraying it. Chemicals come into touch with farmers when spray is applied in the oppositedirection of the wind. This has negative consequences for human health. The vast majority of farmers spray this hazardous chemical without taking the necessary measures. They ingest pesticides frequently. Pesticides come into touch with the skin. As a result, individuals experience a variety of issues such as nausea, skin ailments, digestive problems, asthma, and cancer. The primary goal of this method is to ensure the safety of the farmers, delivering them a machine that is cost-effective, time- saving, and safe. For the system's operation, we used a NodeMCU ESP32 microcontroller. This system is entirely controlled via Bluetooth. As a result, farmers' direct physical touch is limited. Because of less expensive microcontroller, the overall cost of the system is lower.

Shalini D V et. al. published paper on “Automatic Pesticide Sprayer for Agriculture Purpose”. The author created an arm-based device that can drive through the crops on its own. She employed an embedded LPC2148 chip to control the system's functionality. Crop detection is accomplished using an ultrasonic sensor. The ultrasonic sensor detects the crops and transmits the information to the LPC2148 integrated chip. The chips then take the command and switch on the motor, spraying the insecticide liquid over the crops. The system is divided into three stages: transmitter, receiver, and sprayer. In this system, two ultrasonic sensors are used: one on the right side of the system to detect crops from the right side, and the other on theleft side of the system to detect crops from the left side. Both detect surrounding crops and provide a signalto the implanted chip, which activates the pump.



Fig.1. Traditional Pesticide Spraying

DR Mythili C, Jerosheja B R et. al. emphasizes the use of Raspberry Pi was to control the model. They used two controlsystems in this project: field and robot control. For field control, they employed the NodeMCU ESP8266. Moisture, temperature and humidity are recorded in the field with appropriate sensors, the field is adjusted with appropriate actions and the information is sent to the farmer via an app.

Kalpana Murugan, A. Sumanth, B. Jayashankar, C. Venkat Sudarshan, G. Vigandhar Reddy et. al.

studied Smart Automated Pesticide Spraying Bot". The system is controlled using an Arduino Uno. The system is operated with a Bluetooth module. They developed prototype for the operation.

Ugur Celik, Ege Ozgul et.al. studied, Design and Implementation of Semi-autonomous Anti-pesticide Spraying and Insect Repellent Mobile Robot for Agricultural Application". Using current technical breakthroughs, this study depicts the design, construction, and testing of a low- cost semi-autonomous robot dubbed "X- Bot" to make agricultural activities more efficient and precise. For the control, they used the Arduino Mega 2560 microcontroller. The item was discovered using three ultrasonic sensors.

Chun-Mu Wu and Jui Tsung Lu et.al. studied "Implementation of remote control for a spraying robot." This study created a robot that can spray outside. On the hardware side, caterpillar-driven automatic gear shift, steering, engine clutch, spray pump belt control, engine speed control, and spray mechanism modules are designed to implement a safe, stable, and easy-to-use automatic spray robot, increase overcome rough terrain. For obstacle avoidance and autonomous navigation, the robot sensing modules are combined with data from the infrared encoder, accelerometer module, electronics compass, and electronics and image sensors. A perfect and safe spraying robot with path planning and obstacle avoidance mechanism is built, automatic up-down and left-right spraying function reduces spray leakage and post-spray area.

P.C. Bhaskar and N. R. Dhumale et.al. studied "Smart Agricultural Robot for Spraying Pesticide using Image Processing Based Disease Classification Techniques." Based on an IP method, this study proposes an automatic disease categorization and pesticide controller (IPT).

2. Problem Statement

Farmers often face significant health risks when applying pesticides using traditional methods, as they come into direct contact with toxic substances. This exposure can lead to a range of health issues, including nausea, skin disorders, gastrointestinal problems, asthma, and other ailments. Additionally, existing pesticide application systems are typically prohibitively expensive and time-consuming. To address these challenges, we have developed an innovative solution that utilizes a Bluetooth module to minimize direct human contact with pesticides. Our system is designed to be both cost-effective and time-efficient, improving safety and reducing expenses for farmers.

3. Methodology

3.1 Overview

"Automatic pesticide spraying" is the name of a system. The pesticide application process of this system is carried out by the Bluetooth module. The prototype model is constructed, and the microcontroller is attached to it. This system includes the following components:

1. NodeMCU ESP32 microcontroller
2. 12V 5A 30RPM DC motor
3. 12V A 10RPM DC motor 4. L239D
5. Colour sensor

6. Pump and nozzles
7. Rack and pinion mechanism.
8. Relay switch

3.2 Node MCU ESP32

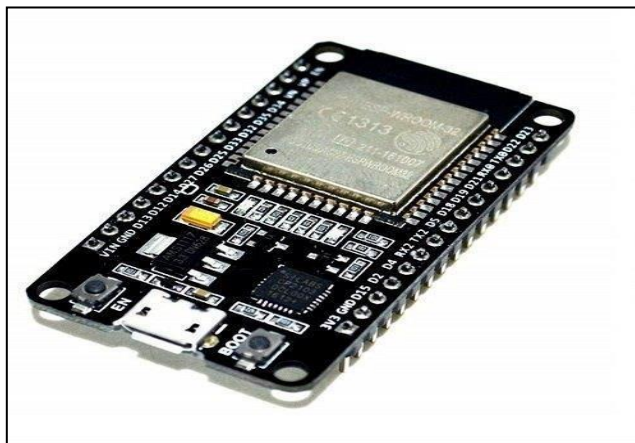


Fig.2. – NodeMCU ESP32

NodeMCU ESP32 is low-cost microcontroller and best alternative option to the Arduino Uno and Raspberry Pi. It comes with the inbuilt Bluetooth module. Its programming is easy as similar to Arduino. If you're familiar with the ESP8266, the ESP32 is a big update with many more functions. As technology advances, new project ideas and implementations emerge, including the Internet of Things (IOT). Similar to ESP8266, ESP32 integrates RF components such as power amplifier, low noise receiver amplifier antenna switching filter and RF balun. This makes it very easy to create hardware for ESP32 as it requires very few external components. The ESP32 consists of the following:

1. ESP-WROOM 32 module
2. Dual rows of IO pins (15 pins on each side)
3. CP 2012 USB to UART Bridge IC
4. Micro USB connector (for power and programming)
5. Activation button for reset
6. Boot button for injection
7. Power LED (red)
8. User LED (blue connected to GPIO2)
9. Some passive components.

3.3 Working

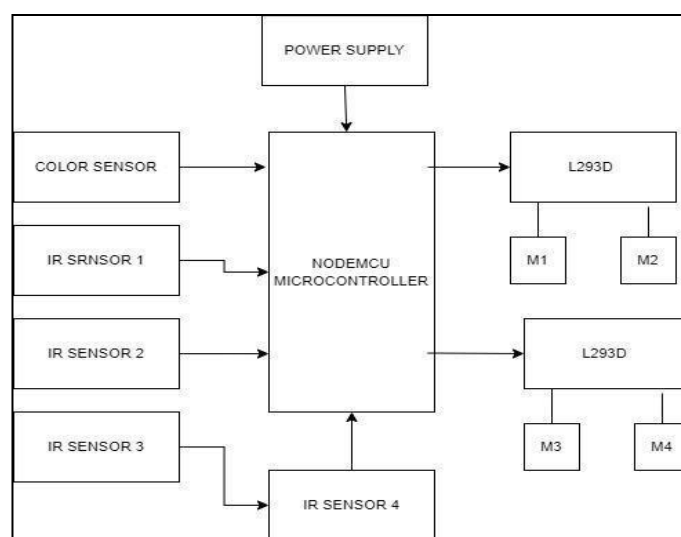


Fig.3. Block Diagram

The power is given to the microcontroller. And relay is connected to the microcontroller. Relay helps to start the pump. L293D is used for the operation of the motors. 4 motors are connected to the wheels for their movement purpose. And 2 motors are used for the operate rack and pinion mechanism. There are two IR sensors and one- colour sensor is used. One IR is placed at the bottom of the system and other is at the top. When we start the microcontroller, the power is supplied to the circuit. Our system starts, then we connect this system with the mobile Bluetooth application with the help of Bluetooth. We have used “Serial Bluetooth Terminal” app. As the system is connected to the app, now we can operate it. There are five commands for the operation:

- a. 1 – Forward movement
- b. 2 – Backward movement
- c. 3 - Left
- d. 4 – Right
- e. 5 – Stop

When the lower IR and colour sensors detect cropping, the system stops and the rack and pinion mechanism descends. After that, pump starts and sprays the liquid through the nozzle over the crops. After completion of the spray, we can operate the system as per the crop position. When upper IR sensor detects the crops., System stops and rack and pinion move in upward direction and pumps starts and it spray the liquid over the crops with the help of nozzle. Similarly, this operation repeated.

This describes the overall working of a system. It requires less skilled person. Also, it helps farmers in their work. Due to the remote control the operation performs in a less time. It requires less time than traditional pesticide spraying method.



Fig.3. Working Model

4. Advantages and Limitations of Automatic Pesticide Spraying Machines

Advantages:

1. **Protection from Harmful Chemicals:** Automatic pesticide spraying machines help protect farmers from direct exposure to harmful chemicals used in pesticides. This is crucial for minimizing health risks associated with handling toxic substances, such as respiratory issues, skin irritations, and long-term health problems.
2. **Reduced Physical Effort:** These machines significantly reduce the physical effort required for pesticide application. Farmers no longer need to manually carry and operate heavy sprayers, which can be physically demanding and tiresome. This ease of use can lead to greater efficiency and productivity.
3. **Portability:** Many automatic pesticide spraying machines are designed to be portable. This feature allows them to be easily moved between different areas of the farm or between different farms. Portability enhances flexibility and convenience in pesticide application, making it easier to manage diverse farming operations.
4. **Cost-Effectiveness:** In many cases, automatic spraying machines can be a cost-effective solution compared to traditional methods. They may reduce labor costs and increase the efficiency of pesticide use. Additionally, precise application can lead to better pest control, potentially reducing the amount of pesticide needed.
5. **Elimination of Physical Contact:** These machines eliminate the need for farmers to have direct physical contact with pesticides. This reduces the risk of exposure to potentially hazardous chemicals, promoting a safer working environment and adhering to health and safety regulations.

Limitations:

1. **Not Suitable for Large Farms:** Automatic pesticide spraying machines may not be ideal for large-scale farming operations. Their design and capacity often limit their effectiveness over vast areas, requiring multiple machines or additional manual labor to cover extensive fields efficiently.
2. **Limited Spraying Capacity:** The capacity of automatic spraying machines can be limited,

especially for smaller models. This can affect the volume of pesticide that can be applied in a single operation, leading to potential inefficiencies or the need for frequent refilling, which may hinder productivity.

3. **Difficult Maintenance:** Maintenance of automatic pesticide spraying machines can be challenging. These machines involve complex mechanisms and electronic components that may require specialized knowledge or training to repair. Regular maintenance and servicing are crucial to ensure their optimal performance, but they can be time-consuming and costly.

Because of this system, a lot of problems are being reduced. It will assist in the application of pesticides across a farm at a low cost. It is within the reach of farmers. Because it operates on an electric supply and NodeMCU ESP32. It requires minimal manual effort and easy to use. We have to support small-scale farmers through this system by providing them with a low-cost machine. Chemicals' negative impacts on human health are reduced as a result.

Conclusion

The introduction of automatic pesticide spraying machines marks a significant advancement in agricultural technology, addressing numerous challenges associated with traditional pest management methods. This system is poised to offer substantial benefits, particularly for small-scale farmers who are often limited by resources and access to advanced technology.

1. **Reduction of Agricultural Challenges:** The automatic pesticide spraying system effectively mitigates many of the problems inherent in manual pesticide application. By automating the process, it ensures a more uniform and efficient application of pesticides across the farm, which not only enhances pest control but also optimizes the use of chemicals. This efficiency helps in managing pests more effectively while reducing wastage and ensuring that pesticides are applied precisely where needed.

2. **Cost-Effectiveness:** One of the most significant advantages of this system is its cost-effectiveness. Traditional methods of pesticide application often involve high labor costs and extensive manual effort, which can be a financial burden for farmers. The automatic spraying machine, by contrast, offers a more economical solution by reducing labor requirements and optimizing pesticide usage. This cost reduction makes advanced pest management technology accessible to farmers, particularly those operating on a smaller scale.

3. **Accessibility and Practicality:** The system's design, which includes the integration of NodeMCU ESP32 technology and reliance on an electric power supply, makes it highly practical and accessible. NodeMCU ESP32, known for its versatility and low power consumption, enhances the machine's functionality, allowing for precise control and automation of the spraying process. The use of an electric power supply ensures that the machine can be used in a variety of settings, provided an electricity source is available. This practical design ensures that the system can be adapted to different farming environments and conditions.

4. **Minimal Manual Effort and Ease of Use:** The automatic spraying machine is engineered to minimize manual effort, thereby reducing physical strain on farmers. Its user-friendly design

allows for easy operation, which is crucial for farmers who may not be familiar with complex machinery. The simplicity of use not only enhances efficiency but also encourages broader adoption among farmers who may previously have been hesitant to embrace new technology.

5. **Health and Safety Benefits:** By reducing the need for direct contact with harmful pesticides, the system contributes significantly to improved health and safety for farmers. Pesticides, when handled manually, pose health risks such as respiratory issues, skin irritations, and long-term health problems. The automatic spraying machine minimizes these risks by automating the application process, thereby protecting farmers from potential exposure to toxic chemicals.

6. **Support for Small-Scale Farmers:** Supporting small-scale farmers through the provision of low-cost automatic pesticide spraying machines is essential for their growth and sustainability. These farmers often operate with tight budgets and limited resources, making affordable and efficient technology crucial for their success. By providing access to such machines, we help them improve their pest management practices, increase crop yields, and enhance their overall productivity.

7. **Long-Term Impact:** The long-term impact of adopting automatic pesticide spraying systems extends beyond immediate cost savings and efficiency gains. It fosters a safer working environment, promotes better health for farmers, and supports more sustainable farming practices. Additionally, by enabling small-scale farmers to manage pests more effectively, this technology contributes to food security and economic stability within farming communities.

The automatic pesticide spraying machine represents a transformative advancement in agricultural technology. Its benefits—ranging from cost-effectiveness and ease of use to improved health and safety—make it a valuable asset for farmers, especially those operating on a small scale. By supporting the adoption of this system, we can enhance the efficiency and safety of pesticide application, ultimately contributing to the well-being and success of farmers and the broader agricultural sector.

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