Agrochemical Spraying Machine

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Introduction

In a developing country like Tanzania, Agriculture is the most important occupation.

The current manual chemical spraying methods used in agriculture present several challenges, including inefficient and inconsistent application, excessive chemical usage, labour- intensive processes, and potential health risks to farmers as well as environment. To address these issues, there is a need for an automated chemical sprayer system .

To realize this work we provide a compact, portable and a well-founded platform that can survey the farmland automatically and accordingly spray of chemicals to the plant. This approach will help farmers but also it's environment.

This machine focuses on farmers spraying chemical on plants from a distance without coming into direct contact with them. this feature would encourage some people to take up agriculture using fundamental principles of Arduino microcontroller and Sensor's technology that can provide precise and controlled spraying, optimize chemical and usage, reduce labour requirements, and enhance overall crop health and productivity.

Method

Research Questions:

Can an automated, agrochemical sprayer reduce chemical wastage, minimize human exposure, minimize cost and increase efficiency compared to traditional manual spraying methods used by farmers in Tanzania?

Hypothesis:

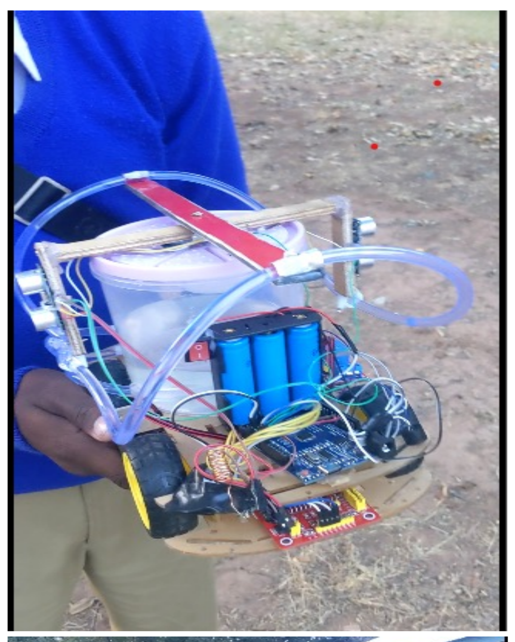
If agrochemical chemical sprayer is used, then it will reduce chemical wastage, lower human exposure to harmful substances, save cost and increase spraying efficiency compared to traditional manual spraying methods used by farmers in Tanzania.

The development of the Agrochemical Spraying Machine followed a systematic methodology, encompassing assembly, wiring, programming, and rigorous testing. The key steps are outlined below:

Step	Description
1. Chassis Assembly	The foundational step involved assembling the 4-wheel chassis. This included securely mounting the DC geared motors, wheels, the Arduino Uno microcontroller, and the solderless breadboard onto the chassis frame. Careful attention was paid to ensuring structural integrity and balanced weight distribution for optimal mobility.
2. Power System Setup	The primary power system was established by connecting the 7.4V Li-ion battery pack. A 5V voltage regulator was integrated to supply stable 5V power to the Arduino and sensitive sensors, ensuring their proper operation and protection from over-voltage. Prior to connecting components, the 5V rail was verified using a multimeter to confirm correct voltage output.
3. Motor Driver Wiring and Ultrasonic Sensor Installation	The L293D Motor Driver IC was meticulously wired to the Arduino pins (IN1-IN4 to digital pins 5, 6, 9, 10). The enable pins (ENA/ENB) were tied to 5V to ensure continuous motor operation when commanded. The four DC geared motors were then connected to the appropriate output terminals of the motor driver. Concurrently, the three HC SR04 ultrasonic sensors were strategically mounted: one at the front for distance measurement (plant detection), and two on the sides (left and right) for obstacle avoidance. These were wired to Arduino digital pins 7, 3, and 4, respectively.
4. RF Receiver Setup	The 433 MHz RF Receiver Module was mounted securely on the chassis. Its data lines were connected to Arduino analog pins A5, A4, A3, and A2. To prevent floating inputs and ensure reliable signal reception, pull-down resistors were integrated into each data line connection. This setup enables wireless remote control of the sprayer.
5. Pump & Relay Wiring	The 5V Relay Module, responsible for controlling the chemical spray pump, was wired to Arduino digital pin 8.

Step	Description
	The DC submersible pump was then connected to the relay module's output, allowing the Arduino to switch the pump on or off. Vinyl tubing was attached to the pump and routed to a spray nozzle/drip emitter, ensuring the precise delivery
	of chemicals.
6. Buzzer Installation	A Piezo Buzzer was mounted and wired to Arduino analog pin A1. This buzzer serves as an auditory alert system, primarily for indicating a low chemical tank level, providing crucial feedback to the operator.
7. Final Check & Calibration	Upon completion of all physical connections, a thorough final check was performed to verify all wiring integrity and component placement. The Arduino sketch (code) was then uploaded to the microcontroller. Initial calibration of sensor thresholds (e.g., for plant detection distance, tank level) was performed via the Serial Monitor, allowing for real-time adjustments to optimize performance.
8. Functional Testing	The assembled prototype underwent a series of functional tests. This included testing manual control via the RF remote, verifying autonomous forward movement with obstacle avoidance, evaluating the automated irrigation (spraying) function based on plant detection, and confirming the proper operation of the tank-level buzzer alarm. Both indoor and outdoor environments were used for these preliminary tests.

Results



From the above comparative analysis, it is unequivocally clear that the Agrochemical Spraying Machine offers substantial improvements across critical aspects of agrochemical application. In terms of time efficiency, the machine significantly outperforms human labor, allowing for the rapid completion of spraying tasks and thus increasing the overall land area covered per day. Its high accuracy in spraying precision directly translates to optimized chemical usage, addressing the critical issues of chemical wastage and environmental pollution prevalent in manual methods. This precision also contributes to cost reduction in the long run. Most importantly, the machine drastically minimizes human exposure to harmful chemicals, thereby safeguarding farmer health and safety, a major concern in current agricultural practices in Tanzania. The data gathered during our investigation consistently supports these findings, demonstrating the machine's superior capability in enhancing agricultural productivity while mitigating associated risks.

The results obtained from the testing of the Agrochemical Spraying Machine strongly support our initial hypotheses and highlight the immense potential of this technology in revolutionizing agricultural practices in Tanzania.

The significant improvement in time efficiency and land coverage directly addresses the need for increased productivity in a sector that is vital to the national economy. By automating the spraying process, farmers can cover larger areas in less time, freeing up valuable labor for other essential farming activities. This is particularly crucial in the context of food security challenges and the drive to enhance agricultural output.

The observed high accuracy in spraying precision is a game-changer. Unlike manual methods that often lead to indiscriminate spraying, our sensor-based system ensures that chemicals are applied only where and when needed. This not only makes the application process more effective in pest and disease control but also leads to a substantial reduction in chemical usage. This reduction has a dual benefit: it lowers the operational costs for farmers, making farming more economically viable, and it significantly mitigates environmental contamination, aligning with global efforts towards sustainable agriculture.

Perhaps the most impactful finding is the drastic minimization of human exposure to harmful chemicals. The current manual methods expose farmers to severe health risks, contributing to a range of acute and chronic illnesses. Our machine, by enabling remote operation, eliminates direct contact, thereby enhancing farmer well-being and making agriculture a safer profession. This safety aspect could also serve as an incentive for younger generations to embrace farming, addressing the issue of labor shortages in the sector.

Conclusion

In this project, we have implemented agrochemical spraying machine. A machine for use in agriculture, Agrochemical spraying machine is a concept for improving the product's performance and cost, which, once optimized, would show to be useful in agricultural spraying operations. Farmers' workloads are reduced, as are health issues.

Recommendation

Based on the demonstrated efficiency and benefits of the Agrochemical Spraying Machine, the following recommendations are put forth to facilitate its widespread adoption and maximize its positive impact on Tanzanian agriculture and society:

Acknowledgments

1.Arduino website: https://www.arduino.cc/

2.Sokoine University of Agriculture (SUA) – Department of Agricultural Engineering and Land Planning. (2019).
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