

A Comprehensive Review of Autonomous Pesticide Spraying Robots for Precision Agriculture

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Abstract - To address the increasing challenges of labour shortage, pesticide application and the health hazards that farmers expose themselves to upon embracing the manual spraying methods, automation in agriculture is very necessary. The solution to these issues is a low-cost and environmentally friendly solution to the problem, which is the development of a robot car that will spray agricultural pesticides using Bluetooth. This paper focuses on the design, implementation, and operation of a robotic spraying machine which is very successful in regulating pesticide spraying by using wireless communication and embedded technology. In order to accurately constitute spraying activities, the system utilizes a 12V DC water pump, DC motors, and servo motors, an Arduino UNO microprocessor, and Bluetooth connectivity via an HC-05 module. Through an Android application, farmers are able to remotely manage the direction, movement and spray mechanism of the robot. This enhances accuracy in spraying, maximization of pesticides and minimization of direct contact with harmful chemicals. The study shows how these low-cost robotic inventions change small to mid-scale farming practices by comparing the literature evaluation and the evaluation by a practical implementation.

Key Words: Pesticide Farming, Spraying Robot, Arduino, Bluetooth Connectivity.

1. INTRODUCTION

1.1 History:

Agriculture still remains the primary rural livelihood and food security in particularly the developing nations. However, the industry continues to experience numerous challenges in regard to labour supply, cost efficiency and safety particularly with the usage of pesticides. Besides

being laborious, manual spraying poses a threat to the farm workers because of the dangerous chemicals involved that are highly detrimental to their health. Moreover, the traditional method of spraying often leads to uneven spraying, use of excessive chemicals, and damage to the environment through spray drift and runoff. To curb these alarming issues, farming is embracing automation and built-in technology to counter the technological integration that is redefining productivity in industries. One of such developments is the robotic pesticide spraying devices. One of such systems, which is reviewed and analyzed in this research, is the Agricultural Pesticide Spraying Robot Car. It sprays pesticides at exact and remote sites over farms through wireless connection and inbuilt control.

Robotic Automation in Agriculture: Grasping this concept is essential to comprehend how agriculture, as a commercial enterprise, can be transformed using robots.

1.2 Robotic Automation in Agriculture:

The understanding of this concept is critical to grasp how agriculture as a business can be revolutionized with the help of robots. Agricultural robotics or Agri-bots is transforming the way farming is conducted by automating hazardous and repetitive jobs. These technologies ensure standardization of activities such as planting, harvesting, and also the use of pesticides besides reducing the dependency on manual labor. This kind of automation has the Pesticide Spraying Robot Car. It involves wireless connectivity, motor drivers and microcontrollers to make the human pesticide spraying process be remotely controlled by a robotic platform. The aim is to make workers safer, reduce the cost of operation, and enhance spray accuracy and still to be affordable and easily employed by the small and medium farmers. A device

intended to achieve this is an embedded system that will be incorporated on the sprayer.

1.3 Embedded Systems to Smart Spraying:

Embedded systems form the basis of modern automation. To control the movement of the robot and its spraying system, an Arduino UNO microcontroller will be used with several hardware modules, such as DC motors, servo motors, a pump with a relay, and Bluetooth module. The simple user interface of an Android application makes targeted spraying and real-time directional control possible. This scalability and customization of this modular design make future enhancement such as GPS integration or sensor-based automation possible. This robot will ensure efficiency, controlled, and safe spraying of pesticides in the field through inbuilt technology.

2. Literature Survey

Recent research indicates that the autonomous pesticide spraying robots are beneficial in minimizing health risks and workforce to farmers. The primary objectives of research are the study of navigation, path planning, and obstacle avoidance based on multi-sensor systems. Development of precision spraying mechanisms is done to minimize the wastage of chemicals and leakage. Android-based wireless control is popularly used to operate many systems, many of which have been developed with MIT App Inventor. Stable motion control and terrain adaptability are the major design elements. The necessity of waterproof equipment, pressure optimization of sprays, is also emphasized in literature. The next generation work focuses on autonomous nature and inbuilt pest surveillance systems [2].

Precision agriculture is also adopting autonomous spraying robots that are helping to minimize the exposure of farmers to pesticides and enhance productivity. Studies have emphasized the need of path planning, obstacle avoidance, and use of multi-sensors to ensure good navigation. The stability and accuracy of spraying are increased with control methods and error-compensation methods. The contemporary spraying systems would strive to avoid leakage and repetition of application. Android control is wireless and enhances usability. New researches emphasize, too, the need to integrate pest monitoring in order to have smart, need-specific spraying. [3]

METHODS & MATERIALS

In this venture, hand-operated or fuel-operated spray pumps are mainly used by farmers. Negative impacts such as rashes on the bodies of the farmers are being realized due to the large thickness and weight of this conventional sprayer, and proximity to the pesticides. This prompted us to develop a model which is basically a robot-assisted sprayer.

Arduino UNO:

Arduino is an open-source electronics platform whose hardware and software are user friendly. It is a platform where electronic creations are created. To teach the project we would like to code, an Arduino consists of a physical programmable board and a bit of software, called an IDE (Integrated Development Environment) that can run on your computer and that you can use to write and upload code to the physical board. As shown in below figure 1



Fig -1: Arduino UNO

Bluetooth Module HC-06:

The HC-06 may be a Bluetooth wireless communication product. It is a module with 6 pins. The device may be used in data mode and command mode. Although the Bluetooth module can have its settings changed through the command mode, data transfer between the devices is done through the info mode. As shown in below figure.

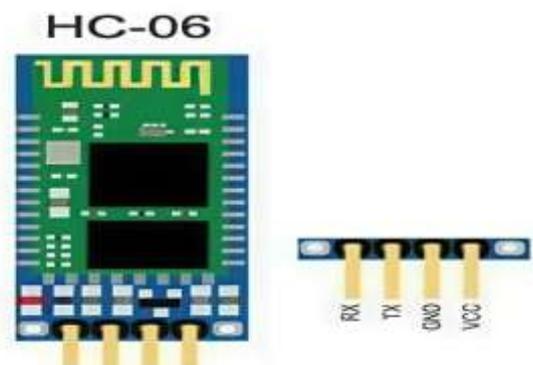


Fig -2: Bluetooth Module HC-06

Motor driver L293D

The L293D is planned to be able to deliver up to 600 milliamperes of bidirectional drive currents at voltages between 4.5 and 36 volts. Examples of inductive loads that can be driven by both devices include relays, solenoids, dc, bipolar stepping motors and others that require high current. An interface between the DC motors and the Arduino is L293D. As shown in figure below.

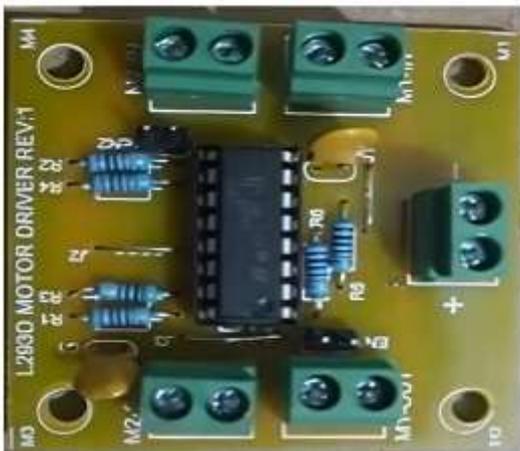


Fig -3: Bluetooth Module HC-06

DC Motor

Any rotary DC motor converting DC current into energy is known as DC motor. The most common types depend on the forces that are produced by magnetic fields. In virtually all forms of DC motor, there is an inbuilt electromechanical or electronic mechanism which enables the current of the motor periodically to reverse direction. As shown in below figure.



Fig -4: DC Motor

Servo Motor

Angular or linear angular position, velocity, and acceleration can be accurately controlled using servomotors, which may also be linear actuators. The servo motor is often able to spin 90deg in either direction, rather than 180deg.

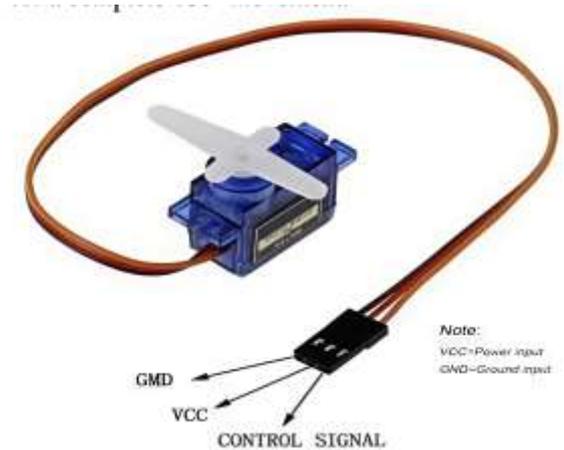


Fig -5: Servo Motor

METHODOLOGY

In order to control this spraying rover, we come up with an android application. To make all devices in the spraying rover controllable, we will have to connect the Android application to the HC05 Bluetooth module first. This spraying rover is easy to use after connecting it to Bluetooth. In this rover we utilized a motor driver L299N that had four DC motors attached to it. Motor drivers connect the microprocessor, Arduino Uno, and DC motor, and a 12V battery is used as the source of power. The motor drivers can regulate the rotation of the motor by connecting the phase of the motor to the gate driver MOSFET on the motor circuit. Some other servo motors also control the sprayer part of this rover. A servomotor is a linear/rotary motor with a fine range of control of acceleration, velocity and angular position. The main role of these servo motors is to move the sprayer according to the requests of the user. These servo motors were used to drive the sprayer with respect to its shoulder component.

The Arduino UNO board functions on the basis of the instructions of the Android apps. When the switch is in the on position, the LED is lit. During the night, there is lighting through LED. In this system, we used a 6V pump, which is attached to Arduino. Given that a microcontroller is incapable of powering a machine that consumes high levels of current, we will employ a current amplifier in order to connect the water motor pump with the microcontroller. MOSFET modules drive motors. Below figure represents Block diagram of the system.

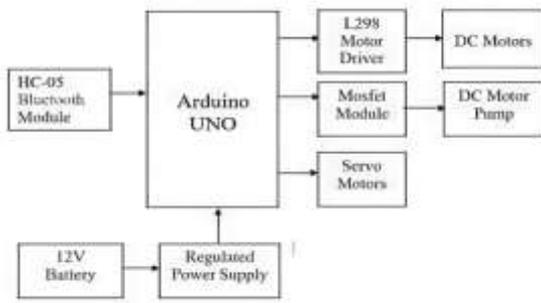


Fig -6: Block Diagram

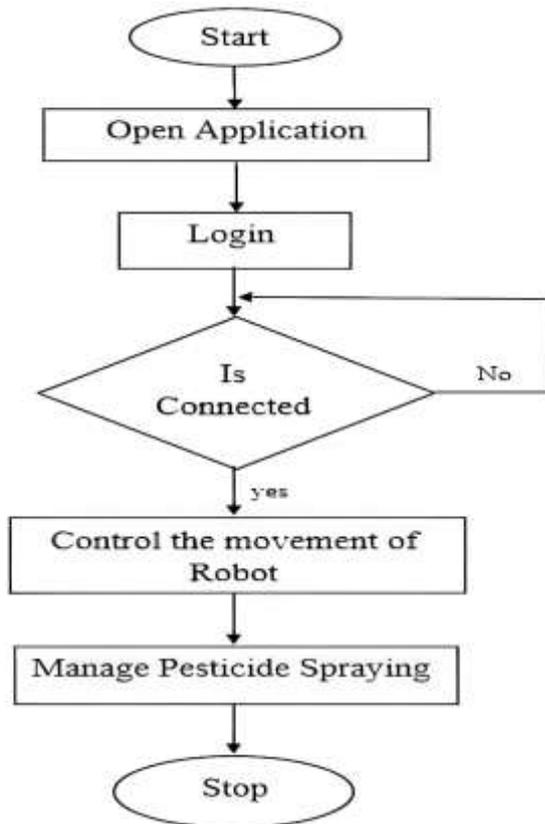


Fig -7: Flow chart of Pesticide Spraying Robot

RESULT

The suggested technique is powered by the battery of 12V. The two DC motors are responsible to the forward, backward, right, and left movement of the ROBOT besides a servo motor that sows and submersible pump that sprays pesticides and a gear DC motor which cuts grass. All of the ROBOT was controlled by the HC-06 Bluetooth module, which is 10 meters long-range.

First is the grass cutting, seeding and spraying which is all part of our frontend part of our ROBOT which is presented here.

There is a battery fitted in the front end as well. The battery of 12 volts is sufficient to allow the ROBOT to perform all the tasks such as cutting and sowing, spraying pesticides and moving the ROBOT.

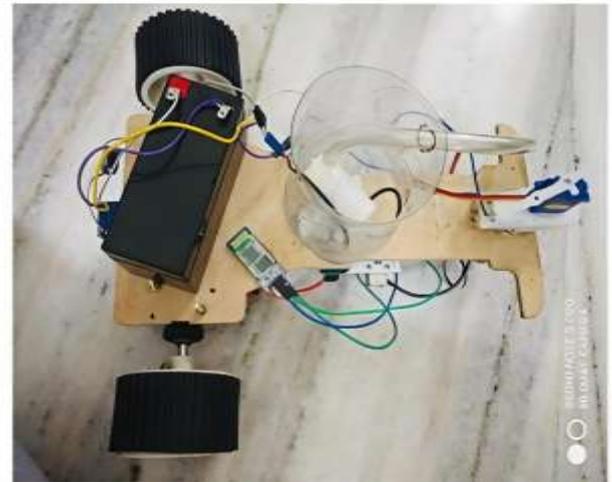


Fig -7: Frontend Section of Robot

Next is the backend section. We made the links and reversed them to conceal all the wires and connections so as to give the BOT a clean and tidy appearance. We have also been able to initiate and terminate the processes of grass cutting, sowing and pesticide spraying independently throughout the application.



Fig -8: Backend Section of Robot

3. CONCLUSIONS

An agricultural robot spraying pesticides is meant to reduce the amount of manual labor carried out in the farms. The main strength of the project and its center of interest is the automated pesticide spraying of the robot controlled remotely through Bluetooth. The only drawback is the use of Bluetooth module. In order to overcome these problems we desire to apply a Wi-Fi module or node MCU in the future. Further research could be conducted on a Raspberry Pi microcontroller which is highly effective and efficient when used in the place of the existing Arduino and Node MCU. The procedure can be made to have better images. Acquired through placing a camera in front of the BOT. This can be operated with IoT having advanced capabilities without any manual labor to be done. We might even develop

drones and train farmers on how to operate them; they would be easy to operate.

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