PESTICIDE SPRAYING ROBOT: THE MECHATRONICS APPROACH TO AGRICULTURE

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ABSTRACT: Herbicides, nematicides, molluscicides, rodenticides, fungicides, insecticides, and other pesticides are all classified as pesticides. Pesticides were designed to kill specific organisms such as insects, pests, rodents, fungi, and so on, but they cause serious harm to human neurological systems and tissues. Pesticides used in Asia accounts for 50% of all pesticide manufacturing worldwide. After China and Turkey, India is the third-largest pesticide consumer in Asia **[1]**. Pesticides have a significant impact on farmers' health since they frequently come into contact with pesticides and there is currently no way to protect them. They are extremely harmful and should be banned immediately, but pest infestation and agricultural destruction will have a disastrous effect on the population of the country. This would not be a good choice in a situation where India's ranking on the global hunger index is constantly declining, but there is a need to identify alternative solutions. Our proposed project involves the use of robots to automate pesticide spraying tasks across a wide area using the Internet of Things. With the help of the Internet of Things, the robotic device is navigated, controlled, and trained to spray insecticide on plants. As a result, farmers are protected from the effects of pesticides as the physical presence of a human is not present in this scenario. The spray robot has the worldwide coverage of information update and video multicast, additional MQ-135 Air Quality Sensors provide many advantages compared to conventional pesticide spraying robots.

IndexTerms—Pesticides, ESP8266, Internet of Things (IoT)

JEL Codes: I18, I11, I15

1. INTRODUCTION

Food, housing, and clothes are the three most fundamental requirements for human survival. It is always considered necessary to look forward to feeding every individual, regardless of how powerful a country is. For millennia, India has been famed for its agricultural riches. Farmers in India are the backbone of its rich agricultural heritage. Pesticide use is unavoidable since pests cause significant crop damage, making it necessary for farmers to treat them with the appropriate chemicals and pesticides. Herbicides and insecticides are the two major types of pesticides that are made up of a mix of natural and synthetic substances. Components of insecticides such as organochlorines, creosote, and sulfallate induce cancer, whereas organochlorines DDT, chlordane, and lindane cause tumours, according to multiple previous studies [2]. Human cells and tissues are highly reactive to these substances. They induce acute irritability, skin problems, and cancer in many circumstances. The vast majority of farmers take the necessary precautions. Even so, pesticides infiltrate their bodies and create serious problems. The Punjab region of India has recently received national attention as a result of multiple incidences of blood cancer among farmers [3]. Insecticides account for the majority of pesticides used in India. Pesticides that cause major tumours and cancer have already been banned in India, but the pesticides that are still allowed have extremely harmful side effects. Our proposed system deals with a pesticide spraying robot that has IP Camera based live feed, Wireless controlled navigation and also Bluetooth controlled robotic pesticide spray.

2. PREVIOUS WORKS

There have been several studies in the field of pesticides and different efficient ways to deliver them to plants with safety. Below are some of the work which matches our domains.

ArasoTayeWaktola et al. performed the work to create an efficient pesticide spraying robot that is practical enough for real-time implementation. The system is based on live mobility and manual control. Their team's system is built on the concept of Bluetooth-based robotic control and plant spraying. It was created for real-time use and proved to be quite valuable in the development of our system. The water tank was attached to the robot's body. This tank served as a pesticide reservoir for the sprayed insecticide. In our study, we employed the attached pesticide tank in the same way. Their work is quite similar to our proposed work, but our paper includes an extra IP camera, an air quality monitoring device, which is a significant improvement over their earlier work. [4].

The Pesticide Sprayer Robot was designed by A.M. Kassim et al. with larger wheels and a more realistic approach. Their robotic system uses an Arduino Mega System, which is similar to the Arduino Nano System. The ultrasonic sensor series is utilized to autonomously navigate the path. Their module can handle a payload of up to 20 kg. The pesticide robot benefits from the greater torque provided by the four-wheel-drive system, but it also necessitates a large power supply. To reduce power usage, the arrangement employs high-capacity 12V and 7AH batteries. Pesticides are sprayed on plants using 12V/70W diaphragm pumps. Mist nozzles of various lengths are used to spray pesticides on plants of various lengths. The diaphragm pumps and BLDC motors are turned on and off by the electromagnetic relay. The technology is quite remarkable, and it must be applied in real-time. In the paper, the ultrasonic sensor setup is particularly impressive [5].

In their study, PvrChaitanya et al. described a pesticide spray robot based on machine vision. The majority of their work is based on machine learning techniques. The image stream is collected by the camera and then processed by the machine learning process. The pesticide spraying nozzle is used to spray pesticides on exposed regions where disease, pests, or diseases are found. The technology uses a machine learning approach to forecast viable cures. The L293D motor diver IC, like our proposed cent, controls the robot's robotic movement. Embedded apps are run on the Raspberry Pi3 system. The code is written in Python and provides a training set for the robot to detect any anomalies on leaves, stems, or plants. The PC and its applications can control the robotic system. This provides the spraying system with an edge of intelligence to actively detect the area to target the pesticide for spray. It helps to save the pesticide and reduce wastage. [6].

3. SYSTEM DESIGN AND SPECIFICATIONS

This technique is intended to address the major problem of pesticide poisoning, which causes significant harm to farmers' hands, legs, and eyes. Pesticide poisoning has invasive consequences such as cancer, organ failure, and, in some cases, death. Many farmers have no idea what they are dealing with; they mistakenly think of pesticide poisoning as mild skin rashes, fever, and the typical cough and cold, but when properly examined, it turns out to be a life-threatening disease. This section contains the exact specifications for creating a pesticide bot. The entire system is broken down into six modules.

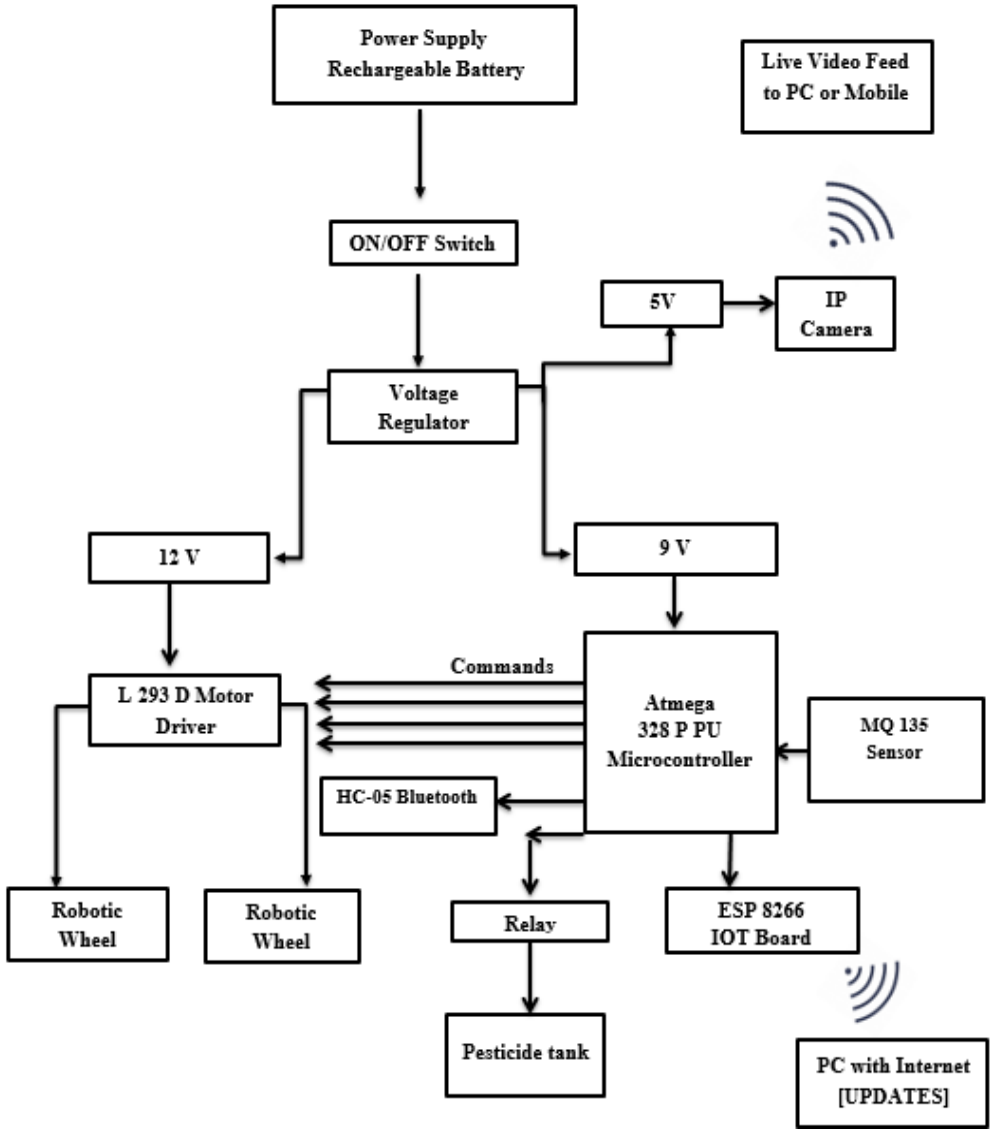

Figure 1: Overall Block Diagram

Power Supply Module: The module for supplying power uses a rechargeable battery as a power source to provide all of the system's energy needs. Various voltage regulators are used to regulating the voltages for various components and their requirements.

Motor Driver Module: The Motor Driver is built around the L293D motor driver IC. The primary responsibility of the motor driver is to regulate the power supply to the wheel motors [7]. The motor driver receives a 12V power supply. When the microprocessor sends 5V directives to the motor driver, the motor driver supplies this 12V power supply to the wheels. We use motor driver ICs to execute such jobs since microcontrollers cannot offer 12V power.

TABLE I: Motor Driver Logic

PIN	STATUS	Motor Movement
A	ON	Motor 1 Clockwise
B	ON	Motor 1 Anticlockwise
C	ON	Motor 2 Clockwise
D	ON	Motor 2 Anticlockwise

Controller Module: The controller module serves as the brain of the entire system. Embedded C code is used to write the overall program logic. The microcontroller we're using is the Atmega 328 P PU, which is a high-

performance 32-Kbyte flash program memory microcontroller. It is inexpensive and uses very little energy. It is simple to program using the Arduino IDE. The microcontroller is capable of efficiently and accurately managing all of the modules [8].

Data transmission and reception module:
The data transmission and reception module of our robotic system is divided into two sections.
The IoT transmission module comes first, followed by the Bluetooth data transceiver module.
IOT Transmission Module: The IoT transmission module is in charge of transferring all environmental data collected from the city to a central cloud server. The module updates the dedicated website with information such as the moment the robotic system started working, how long the pesticide sprayer operated, how much pesticide was sprayed, data acquired from an air quality sensor to assess toxic air levels, and so on. To complete the task, we use an ESP8266 IOT board, which is a WI-FI based IoT system that may be powered by a dedicated Wi-Fi system or even mobile phone hotspots [9].
The HC-05 Bluetooth module: The HC-05 Bluetooth module is used to connect the robot to the Android applications from a safe distance. Bluetooth is a lag-free technology that allows our robot to be extremely solid and steady when performing tasks in the field. The serial data provided by the Android phone is decoded into data series, received by Bluetooth, and forwarded to the microcontroller, where it is matched with the given task according to the system's program logic [10].
Switching Module: Relays and relay drivers make up the Switching Module. To drive 12V relays from 5V microcontroller commands, we used the ULN 2003 IC [11]. The magnetic field formed in the coils as a result of applied electric charges causes the electromagnetic relays to move. The coil movement activates and deactivates relay switching between the NO and NC pins, which is used to switch pesticide spraying motors and other components.
Sensor Module: Our project also includes an MQ-135 air quality sensor, which can detect a variety of toxic and hazardous substances in the atmosphere. It can give us information about the air we breathe, such as whether it is safe to breathe or not. It can detect NH3, NOx, alcohol, benzene, smoke, and CO2, among other gases [12]. This sensor is utilized to detect the presence of dangerous gases in our project, particularly when pesticides are employed.

4. RESULT AND DISCUSSION

The proposed robotic system is installed on a sunmica body with appropriately attached components for easy operation. The large 10x4 CM wheels are coupled to a 60 RPM geared motor to provide great torque while maintaining optimal speed. The system is efficient enough that this can work as Sanitizer sprayer in Covid type of pandemics [13][14].

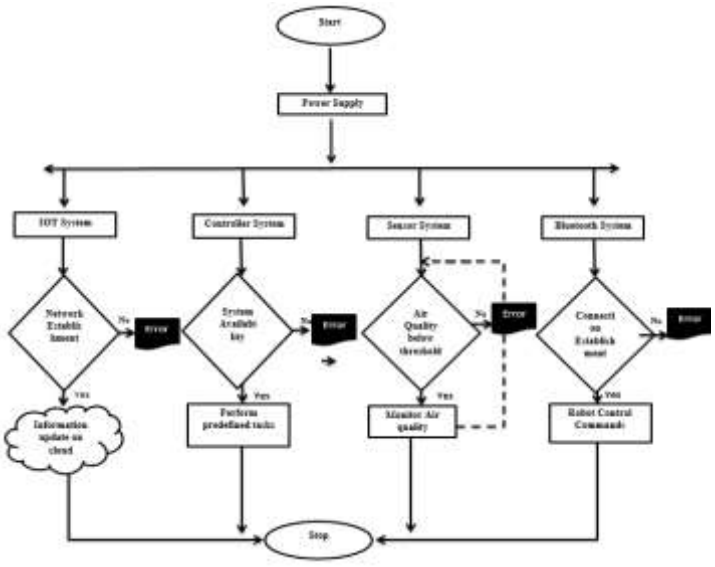

Figure 2: System Flow Diagram

The system is capable of completing the task assigned to it. The water pump motor is a DC pump system that delivers a water jet as a spray to the plant, allowing the pesticide to reach the intended area. The entire arrangement is put through its paces in real-time.

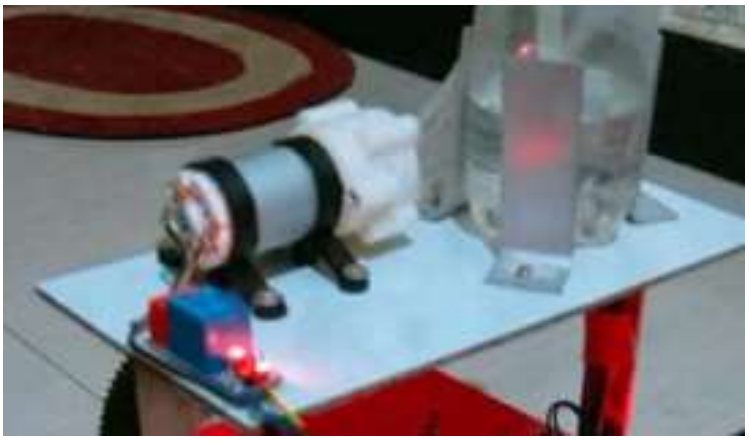

Figure 3: Spray Pump Setup

The overall system implementation is present below, some components are beneath the sunmica body to provide a neat look to the overall setup.

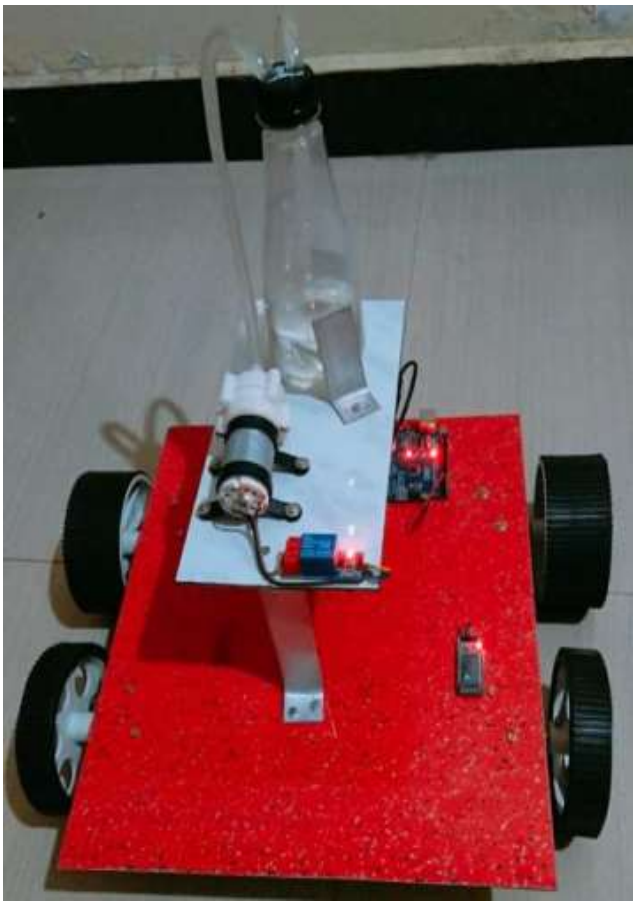

Figure 4: Overall Implementations

The simple design makes it easily fabricable for regular usage. There are several possibilities to enhance the system design as the wheels can be changed with tracked wheels, the connection range can be enhanced with RF or Zigbee System and the metallic body can be further strengthened by using fibre.

5. CONCLUSION

Thus we developed a system of pesticide spraying robots to help farmers to come out of the ill effects of pesticides. Pesticides are the important ingredients of the agriculture system and it's not possible to stop using pesticides. Of course, its usage should be minimized to avoid its ill effects and our robotic system is the technology that can efficiently operate. There is a huge possibility of enhancement in our project in future like increasing its range, weight loading capacity, intelligence and battery power but the present system helps us to estimate the enhancement possibilities in real-time.

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