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Pesticide Sprayer Spider Robot With Grass Cutter

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Abstract: Agricultural automation is becoming essential for improving productivity, farmer safety, and sustainable farming practices. Traditional activities such as manual pesticide spraying and grass cutting are labor-intensive and expose farmers to harm ful chemicals and physical strain. To address these challenges, this paper presents the design of a solar-powered Pesticide Sprayer Spider Robot integrated with a grass cutting mechanism for smart agricultural applications. The proposed system is built around a microcontroller-based architecture integrated with sensors such as ultrasonic sensors for obstacle detection, infrared sensors for spraying logic, and GPS for location tracking. The spider-like leg structure enables stable movement across uneven farm terrain where conventional wheeled robots may struggle. A compact pump and nozzle system performs targeted pesticide spraying, while a lightweight DC motor with blades enables efficient grass cutting. The robot can be controlled through an Android-based interface that allows users to monitor sensor data and operate the system remotely. Experimental tests demonstrate effective obstacle detection, responsive spraying, and reliable grass cutting performance. The proposed system offers a low-cost, eco-friendly solution that reduces human effort and chemical exposure while supporting the development of precision agriculture.

Index Terms- Agricultural automation , Precision agriculture , Solar-powered robot , Pesticide spraying system, Grass cutting mechanism

I. INTRODUCTION

A field is a messy place. Soil is uneven, plants are irregular, and time is always short. Agriculture still depends a lot on manual work for tasks like pesticide spraying and grass cutting, even though these jobs are repetitive and often risky. Pesticides protect crops but expose farmers to chemicals that can cause respiratory issues, skin irritation, and long-term health problems. Grass cutting, on the other hand, requires physical effort and becomes inefficient in large or uneven fields. These challenges encourage researchers and engineers to seek automation. Machines can handle repetitive work while humans supervise from a safer distance.

Recent advances in robotics, embedded systems, and sensor technology have paved the way for practical agricultural robots. Microcontrollers, affordable sensors, and wireless communication modules now enable the creation of compact machines that can sense their environment, move intelligently, and perform specific farming tasks. Precision agriculture, which uses data and automation, relies on these tools. Robots equipped with sensors can identify obstacles, monitor crops, and carry out targeted actions like spraying or cutting, reducing wasted chemicals and labor.

This paper introduces a Pesticide Sprayer Spider Robot with Grass Cutter, a multifunctional robotic platform designed to automate two important agricultural tasks. The robot features a spider-like leg mechanism powered by servo motors, allowing it to traverse uneven terrain where wheeled systems

might struggle. A pesticide spraying module applies chemicals in a controlled manner, while a DC-motor-driven cutter trims unwanted grass. Sensors like ultrasonic and infrared modules help the robot detect obstacles and guide its operations, and wireless communication allows remote control through a mobile interface.

By combining mobility, sensing, and two agricultural functions into one system, the proposed robot aims to lessen manual labor, reduce human exposure to pesticides, and improve efficiency in field maintenance. The design focuses on affordability, modularity, and ease of use to make it suitable for small and medium-scale farms. The following sections outline the proposed system, its architecture, components, and experimental evaluation.

II. PROPOSED SYSTEM

The proposed system is an agricultural robot designed to automate pesticide spraying and grass cutting in farming environments. It aims to reduce human effort, decrease exposure to harmful chemicals, and improve the efficiency of regular agricultural tasks. The robot features a spider-like structure that allows it to navigate uneven terrain commonly found in fields.

The system includes several hardware parts, such as an Arduino Nano microcontroller, multiple servo motors for leg movement, a pesticide spraying mechanism, a grass cutting unit, and communication modules. The Arduino Nano serves as the central controller of the robot, managing the leg movements, the spraying system, and the grass cutting mechanism.

To navigate efficiently, the robot uses ultrasonic sensors for obstacle detection. These sensors measure the distance between the robot and nearby objects, helping the system avoid collisions during operation. Additionally, infrared sensors as sist with color-based detection and spraying logic, ensuring that pesticides are applied only where needed.

The pesticide spraying system consists of a mini pump and nozzle setup that distributes pesticides in a controlled way. At the same time, a DC motor-driven cutter trims unwanted grass and weeds in the farming area. This dual function allows the robot to carry out various agricultural tasks using a single platform.

The system supports wireless communication through Bluetooth and Wi-Fi modules, enabling remote control via a smartphone interface. Users can monitor the robot's operation, control its movement, and activate spraying or cutting functions using a mobile device.

Overall, the proposed system combines robotics, embedded systems, and sensor technology to create a compact, afford able, and multifunctional agricultural robot that can enhance farming efficiency and lessen manual labor.

III. SYSTEM ARCHITECTURE

The system architecture of the proposed Pesticide Sprayer Spider Robot is designed in such a way that it has sensing, processing, and actuating parts that work in coordination with each other for efficient performance of the agricultural task. The Arduino Nano microcontroller is the main controller of the system, which processes the sensor data and controls the movements of the robot.

The ultrasonic sensor is used for obstacle sensing, which helps the robot move safely in the field. The movement of the robot is achieved using multiple servo motors, which control the spider leg movement of the robot.

The pesticide sprayer is designed using a pump and nozzle system for efficient spraying of pesticides, and the cutter is designed using a DC motor for efficient cutting of the grass.

The communication module, such as HC-05 Bluetooth and ESP8266 Wi-Fi, is used for efficient control of the robot using a mobile device.

The system architecture of the proposed Pesticide Sprayer Spider Robot is efficient for performing the task of spraying and cutting the grass in an agricultural field.

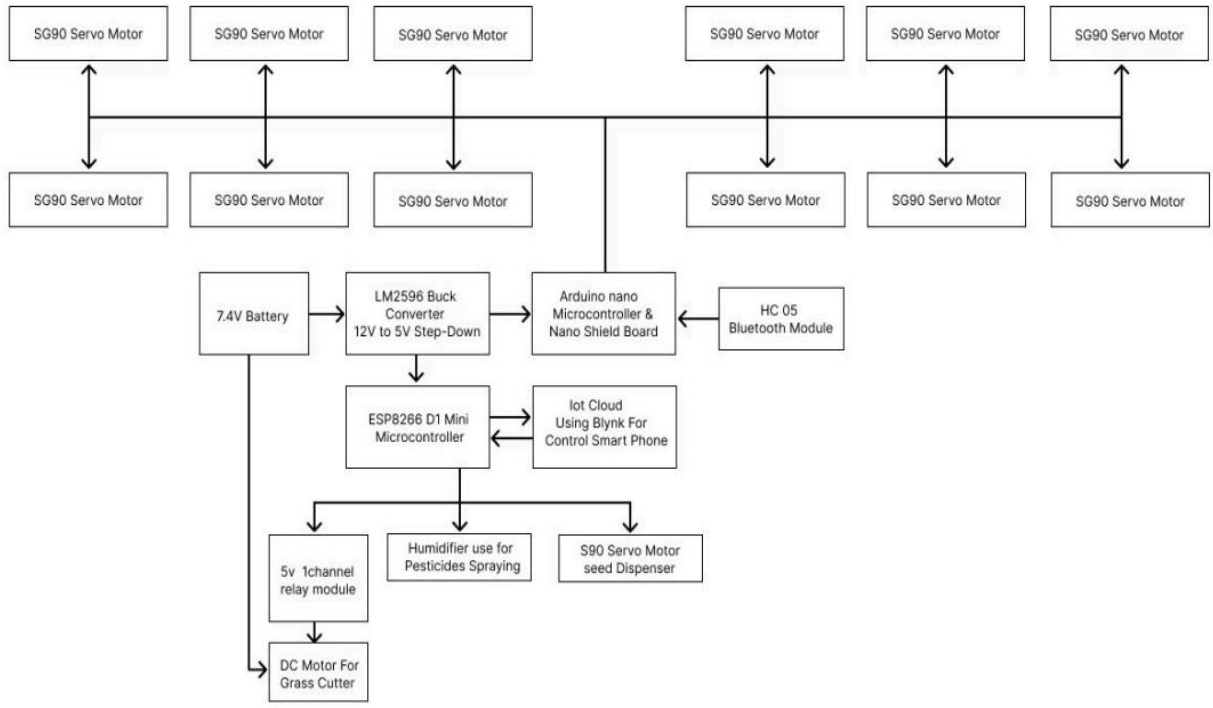

Fig. 1. System Architecture

This system architecture illustrates the interaction between the user interface, processing layer, and database modules.

IV. MODULE DESCRIPTION

A. Arduino Nano

The Arduino Nano is the main controller of the spider robot. It receives input from the sensors and controls the movements of the servo motors, the pesticide sprayer, and the grass cutter motor. It is small and efficient for controlling embedded systems like the spider robot.

B. Ultrasonic Sensor

The ultrasonic sensor is used as an obstacle detection device. It operates by sending ultrasonic waves, detecting the time taken to return after reflecting off an object, and then calculating the distance between the robot and the obstacle based on this information. This helps the robot move safely in the field.

C. Servo Motors

Servo motors are used to control the spider-like leg movement of the robot. Multiple SG90 servo motors provide precise angular control, allowing the robot to walk, turn, and maintain stability on uneven terrain.

D. Bluetooth Module (HC-05)

The HC-05 Bluetooth module enables wireless communication between the robot and a smartphone. Through this module, users can send movement commands and control the spraying or cutting operations remotely.

E. Pesticide Spraying Unit

The pesticide spraying unit consists of a small pump and nozzle mechanism. It allows controlled spraying of pesticides on crops, reducing chemical wastage and improving spraying efficiency.

F. Grass Cutting Mechanism

The grass cutting system uses a DC motor connected to rotating blades. This mechanism trims unwanted grass and weeds in agricultural fields, helping maintain crop areas effectively.

V. RESULTS AND DISCUSSION

The proposed Pesticide Sprayer Spider Robot was tested in controlled environments to evaluate its performance in movement, obstacle detection, pesticide spraying, and grass cutting operations. The spider-like leg mechanism enabled the robot to move steadily across uneven surfaces, demonstrating better stability compared to conventional wheeled robots.

The ultrasonic sensor successfully detected obstacles within a safe distance, allowing the robot to avoid collisions during operation. The pesticide spraying unit delivered controlled spraying through the pump and nozzle system, reducing chemical wastage. At the same time, the grass cutting mechanism driven by a DC motor effectively trimmed unwanted grass in the testing area.

Wireless communication through the Bluetooth module allowed users to control the robot remotely using a smartphone interface. The system responded quickly to user commands, ensuring smooth operation. Overall, the experimental results show that the robot can perform both pesticide spraying and grass cutting efficiently while reducing human effort and exposure to harmful chemicals

VI. CONCLUSION AND FUTURE WORK

In this paper, the design and development of a Pesticide Sprayer Spider Robot with Grass Cutter were presented, which aims to improve the efficiency and safety of agricultural activities. The system consists of a microcontroller-based controller, sensors, servo motors, as well as a spraying and cutting mechanism, which are used to automate agricultural activities. The spider robot has a stable walking mechanism, while the ultrasonic sensor helps in detecting obstacles during operation.

As presented in the experimental results, the spider robot can successfully perform the tasks of spraying pesticides as well as cutting the grass, while the wireless communication helps in controlling the robot remotely. The proposed system helps in improving agricultural activities, as the usage of pesticides can be reduced, ensuring the safety of the farmers. In future, the system can be improved by incorporating AI technology, sensors, as well as solar power, which can improve the efficiency of the system, making it suitable for precision agricultural activities.

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