International Journal of Interdisciplinary Innovative Research & Development (IJIIRD)
ISSN: 2456-236X
Vol. 10 Issue 01 | 2025

Autonomous Solar-Powered Agricultural Spraying Robot with Remote Monitoring

S. D. Lavange[1], Y. P. Sushir[2], A. E. Halde[3], N. R. Budukhale[4]
[1,2,3,4] Assistant Professor, Department of Electrical Engineering, Padm.VBKCOE Malkapur, Maharashtra,India

DOI: 10.5281/zenodo.16309396

ABSTRACT

India is the farmland with a population of three-fourths in agriculture. In accordance with the climate and other resources accessible to them, farmers will grow multiple plants in their field. But some technical abilities along with technological assistance are required to achieve high output and excellent quality. The management of food crops includes very close surveillance, particularly with regard to the treatment of Illnesses, which will cause severe effects after harvest. This is very necessary for effective spraying of the pesticide. In recent years the agricultural industry is revolutionized by automation and robotics that has resulted in reduction of labor and production costs with increased agriculture produce to meet the market demand. Manual spraying of pesticides and herbicides to crops and weed inhibitors onto the field are harmful to both humans and the environment. This project proposes a solar powered, flexible, semi-automated pesticide spraying robot with wireless camera interface. The spraying system is operated by wireless remote control. The robot is designed to spray pesticide/insecticide directly onto individual lesions minimizing wastage leading to reduced consumption of chemicals hence making the system cost effective and environmentally friendly. The targeted pesticide delivery prevents dispersion of chemicals in the environment. A prototype is developed and tested on different terrain conditions and is found to operate efficiently. The movement of robot is done with wireless remote; motor driver and the processor or embedded system is done through microcontroller. Since this can be controlled from anywhere without working in the field and being exposed to pesticides, it will be a profit for the farmer. He will stay unaffected by his health condition.

Keyword: - Pesticide Sprayer Robot, Solar power, Autonomous Robot, Wireless Camera Monitoring, Environmentally Friendly Farming

1. INTRODUCTION

In modern agriculture, increasing productivity while ensuring the safety of farmers and minimizing environmental impact is more critical than ever. Traditional pesticide spraying methods often expose farmers to harmful chemicals, involve intensive labor, and are not always efficient in terms of coverage and precision. To address these challenges, we propose the Solar Powered Pesticides Spraying Robot with Wireless Camera The integration of solar power, automation, and wireless communication makes this robot a smart, safe, and sustainable alternative to traditional pesticide application methods. It represents a significant step forward in the evolution of smart farming technologies. Agriculture is the backbone of human civilization, providing sustenance and livelihoods to billions worldwide. However, traditional agricultural practices, including pesticide application, have often been associated with challenges such as overuse of chemicals, environmental degradation, and reduced biodiversity. In response, the agricultural industry has been undergoing a transformation towards more sustainable and efficient methods, with precision agriculture emerging as a key paradigm shift. an innovative and ecofriendly solution aimed at automating pesticide application in farmlands. This autonomous robot is designed to navigate agricultural fields and spray pesticides evenly, reducing manual labor and human exposure to toxic substances. Powered by solar energy, it promotes sustainable farming practices by reducing dependency on conventional energy sources. Equipped with a wireless camera, the robot offers real-time monitoring and remote-control capabilities, allowing users to track its movements and spraying operations from a safe distance. This feature is particularly useful for precision agriculture, where targeted pest control is essential.

1.1 Objective

The objective of a solar pesticide spraying robot is to make agricultural practices more sustainable, efficient, and environmentally friendly. The goals of solar pesticide spraying robots include- Reducing pesticide use: By using targeted application, solar-powered robots can help reduce the number of pesticides used. Reducing environmental

impact: Solar-powered robots can help reduce the negative environmental impact of conventional farming methods. Reducing farmer risk: Solar-powered robots can reduce the risk of breathing and physical problems for farmers. Reducing workload: Solar-powered robots can reduce the time and workload required for spraying pesticides.

1.2 Methodology

Proposed model reduces the drudgery of farmer as it uses semiautomatic robotic vehicle. It uses a mobile application and wireless remote for to control the spraying operation and movement of the vehicle. This will reduce the exposure of chemicals as it can be operated from safe distance. Agriculture remains the backbone of many economies, especially in developing countries where a large portion of the population relies on farming for their livelihood. Despite technological advancements in other fields, many agricultural practices— particularly pesticide spraying still depend heavily on manual labor, posing serious health risks and inefficiencies.

2. DESIGN METHODOLOGY

The project combines several areas of engineering and technology, including renewable energy systems, robotics, wireless communication, and agricultural automation. The theoretical foundation is built upon the integration of these components to achieve efficient and eco-friendly pesticide application in agricultural fields.

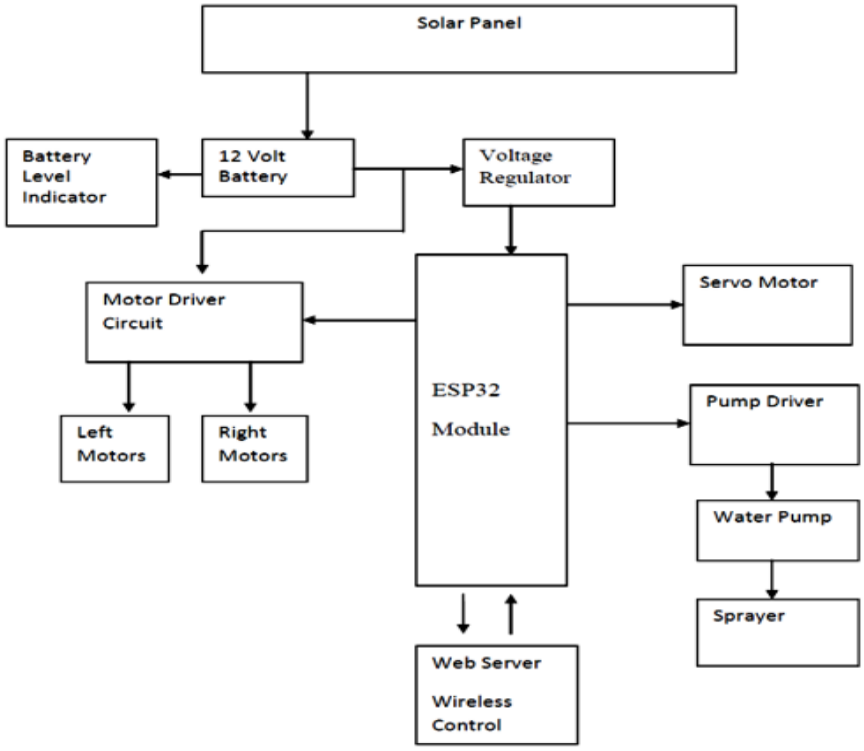

Fig -1: Block Diagram

2.1 DC Gear Motors

The motors are used for the movement of the robotic vehicle, which are of DC gear motors operated at 12V DC power supply. Two motors have been used to rotate the two wheels clockwise or anticlockwise. This provides motion to the robot. Motors are arranged in a fashion called H-Bridge. H-Bridge is an electronic circuit which enables a voltage to be applied across a load in either direction. It allows a circuit full control over a standard electric DC motor. That is, with a Hybridge, a microcontroller, logic chip, or remote control can electronically command the motor to go forward, reverse, left, right and stop. A geared DC Motor has a gear assembly attached to the motor. The speed of motor is counted in terms of rotations of the shaft per minute and is termed as RPM. The gear assembly helps in increasing the torque and reducing the speed. Using the correct combination of gears in a gear motor, its speed can be reduced to any desirable figure. This concept where gears reduce the speed of the vehicle but increase its torque is known as gear reduction. This Insight will explore all the minor and major details that make the gear head and hence the working of geared DC motor.

2.2 Servo Motor

A small servo is a motor that converts electrical signals into mechanical motion. It is a rotary or a linear actuator capable of turning to a predetermined position, exactly as commanded. Servos can also stably hold and re-establish position. If an external force causes a servo to shift from a settled angle, the controller drives the servo to overcome the load. Apart from providing a disturbance rejection, controllers also track input There are lots of servo motors available in the market and each one has its own specialty and applications. The following two paragraphs will help you identify the right type of servo motor for your project/system. Most of the hobby Servo motors operates from 4.8V to 6.5V, the higher the voltage higher the torque we can achieve, but most commonly they are operated at +5V. Almost all hobby servo motors can rotate only from 0° to 180° due to their gear arrangement so make sure you project can live with the half circle if no, you can prefer for a 0° to 360° motor or modify the motor to make a full circle. The gears in the motors are easily subjected to wear and tear, so if your application requires stronger and long running motors you can go with metal gears or just stick with normal plastic gear. Next comes the most important parameter, which is the torque at which the motor operates. Again, there are many choices here but the commonly available one is the 2.5kg/cm torque which comes with the Torpor SG90 Motor. This 2.5kg/cm torque means that the motor can pull a weight of 2.5kg when it is suspended at a distance of 1cm. So, if you suspend the load at 0.5cm then the motor can pull a load of 5kg similarly if you suspend the load at 2cm then can pull only 1.25. Based on the load which you use in the project you can select the motor with proper torque. The below picture will illustrate the same. After selecting the right Servo motor for the project, comes the question how to use it. As we know there are three wires coming out of this motor.

2.3 ESP32 Cam Module

ESP32-CAM is a low-cost ESP32-based development board with onboard camera, small in size. It is an ideal solution for IoT application, prototypes constructions and DIY projects. The board integrates WIFI, traditional Bluetooth and low power BLE, with 2 high performance 32-bit LX6 CPUs. It adopts 7-stage pipeline architecture, on chip sensor, Hall sensor, temperature sensor and so on, and its main frequency adjustment ranges from 80MHz to 240MHz. Fully compliant with WIFI 802.11b/g/n/e/i and Bluetooth 4.2 standards, it can be used as a master mode to build an independent network controller, or as a slave to other host MCUs to add networking capabilities to existing devices ESP32-CAM can be widely used in various IoT applications. It is suitable for home smart devices, industrial wireless control, wireless monitoring, QR wireless identification, wireless positioning system signals and other IoT applications. It is an ideal solution for IoT applications.

3. DESIGN IMPLEMENTATION & WORKING

The design and implementation of the Solar Powered Pesticides Spraying Robot with Wireless Camera involves the integration of hardware components, embedded systems, and control mechanisms to achieve autonomous or remote-controlled pesticide spraying in agricultural fields. The system is modular, allowing for easy upgrades and maintenance. The ESP32CAM is a tiny module based on ESP32 chip and OV2640. You can even program the ESP32CAM through the ESP-IDF by installing the ESP32 Core. The ESP32CAM equips the ESP32 with everything necessary to program, run and develop on the wonder chip. It also features a Lead charger (IP5306), so your ESP32CAM project can be battery-powered and truly wireless. ESP integrates WIFI, traditional Bluetooth and BLE Beacon, with 2 high-performance 32-bit LX6 CPUs, 7-stage pipeline architecture, main frequency adjustment range 80MHz to 240MHz, on-chip sensor, Hall sensor, temperature sensor, An Arduino operating system-based solar pesticides spraying robot platform with remote monitoring and control algorithm through Internet of Things has been developed which will save human live, labor cost, reduces manual error and protect the crops. The system comprises the ESP32 CAM module (small single-board computer), High Pressure Pump, Spraying Nozzle. The Esp32 is the brain of the system. Esp web server controls the robot operation the moving to a specific direction and camera for live streaming videos of required areas. The user is able to access the system with controlling the robot operations.

4. CONCLUSIONS

The development of the Solar Powered Pesticides Spraying Robot with Wireless Camera marks a significant step toward the modernization and sustainability of agricultural practices. This project effectively demonstrates how renewable energy, automation, and wireless technology can be integrated to create a smart farming solution that addresses key issues faced by farmers today. By utilizing solar power, the robot operates independently of external energy sources, making it especially useful in rural or off-grid areas. The automated spraying mechanism reduces

human exposure to harmful chemicals, enhances spraying efficiency, and minimizes labor costs. The inclusion of a wireless camera allows for real-time monitoring and remote control, increasing convenience, precision, and safety during operation. Overall, this robot not only improves the efficiency of pesticide application but also promotes eco-friendly and farmer-friendly innovations. With further enhancements such as GPS-based navigation, advanced obstacle detection, and AI-driven crop analysis, this project has the potential to evolve into a robust, multi-functional tool for smart agriculture.

5. REFERENCES

[1]. Adithya J., Aftab Pasha H., Balaji V., Rohitha R and Kiran Kumar B M., 2019. Design and Development of Solar Powered Automatic Grain Dryer for Storage. IEEE International Conference on Distributed Computing, VLSI, Electrical Circuits and Robotics (2019 IEEE DISCOVER), MIT, Manipal.
[2]. R Shamshiri, R., Weltzien, C., Hameed, I.A., J Yule, I., E Grift, T., Balasundram, S.K., Pitonakova, L., Ahmad, D. and Chowdhary, G., 2018. Research and development in agricultural robotics: A perspective of digital farming.
[3]. Yallappa, D., Palled, V. and Veerangouda, M., 2016, October. Development and evaluation of solar powered sprayer with multi-purpose applications. In Global Humanitarian Technology Conference (GHTC), 2016 (pp. 1- 6). IEEE.
[4]. Robotics, E.U., 2013. Robotics 2020 Strategic Research Agenda for Robotics in Europe, draft 0v42, 11 October. Google Scholar
[5]. Schütz, C., Pfaff, J., Baur, J., Buschmann, T., Ulbrich, H. and Idea, G., 2014. A modular robot system for agricultural applications. In Proceedings International Conference of Agricultural Engineering, Zurich.
[6]. Aishwarya.B.V, Archana.G, C. Umayal. "Agriculture robotic vehicle-based pesticide sprayer with efficiency optimization", 2015 IEEE Technological Innovation in ICT for Agriculture and Rural Development (TIAR), 2015.
[7]. J. Biswas, and M. Veloso, “Multi-sensor mobile robot localization for the diverse environment”, Robo Cup 2013: Robot World Cup XVII, vol. 8371, pp. 468-479, 2016.
[8]. Kalpana Murugan; B. Jaya Shankar; A. Sumath; C. Venkat sudharshan; G. Vigandhar Reddy “Smart automated pesticide spraying Drone” 2020.
[9]. Autonomous Seed Sowing Agricultural Robot Jayakrishna P V S Suryavamsi Reddy, Jaswanth Sai, Susheel N, Peeyush K P Department of Electronics and Communication Engineering Amrita School of Engineering, Coimbatore Amrita Vishwa Vidyapeetham, India.