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Android Operated Solar Disinfectant Sprayer Robot

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Abstract- Efficient and safe pesticide application remains a significant challenge in small- and medium-scale agriculture in India, where manual spraying exposes farmers to harmful chemicals and limits operational productivity. This study presents the design, development, and testing of a solar-powered, remote-controlled automatic pesticide spraying robot. The system integrates mechanical, electrical, and control subsystems, including DC motors for wheel movement, a DC pump for spraying, a multi-nozzle assembly, rechargeable batteries, and a Bluetooth-based control unit. The robot provides uniform pesticide distribution, adjustable nozzle height, and autonomous navigation over uneven terrain. Experimental results demonstrate that the robot can cover wide areas efficiently, with a flow rate of 3.16 liters per minute through four nozzles and a remote operation range of up to 50 meters, minimizing operator exposure to chemicals. The solar-assisted power supply ensures sustainable operation in rural areas with limited electricity access. The proposed system reduces labor requirements, enhances spraying uniformity, and provides a cost-effective, safe, and practical solution for agricultural pesticide application and disinfection in public spaces.

Keywords: Solar-Powered Sprayer, Automatic Pesticide Application, DC Motor-Driven Robot, Remote-Controlled Spraying, Agricultural Automation

I. INTRODUCTION

India is predominantly an agrarian country, with nearly 70% of the population residing in rural areas and relying on agriculture as their primary source of income, either directly or indirectly [1]. Despite the large workforce involved in farming, the nation still lags behind its potential agricultural productivity. One of the critical reasons for this shortfall is the limited adoption of modern agricultural technologies [2]. Increasing productivity and profitability in Indian agriculture requires the development of cost-effective, technologically advanced machinery. Given the relatively low per capita income of Indian farmers, such machinery must be affordable, efficient, and easy to operate. Currently, most Indian farmers use hand-operated or motorized backpack sprayers for pesticide application [3]. Hand-operated sprayers are inexpensive but suffer from limitations such as low efficiency, slow operation, uneven coverage, and direct exposure of farmers to harmful chemicals. Motorized sprayers provide better performance but remain costly, heavy, and require maintenance, making them unsuitable for small and marginal farmers, who constitute the majority of India's agricultural workforce [4]. Mechanized spraying systems such as tractor-mounted boom sprayers, widely used in developed countries, are highly productive but require high capital investment, tractor availability, and large open fields—conditions not feasible for most Indian farms [5]. Low-cost innovations have emerged locally to address these challenges. For instance, Mansukhbhai Jagani developed a multi-purpose agricultural bike attachment capable of sowing, cultivating, spraying, and furrowing. While this system is multifunctional and relatively affordable, it still relies on manual operation, limiting its automation potential [6]. Thus, there exists a clear need for a spraying solution that is automated, safe, and tailored to the rural Indian agricultural environment.

Recent studies highlight advancements in agricultural spraying technology, particularly automation and precision application. Terra et al. (2021) developed an autonomous sprayer with machine vision for real-time plant detection, enabling per-nozzle precision pesticide application [7]. Nasir et al. (2023) implemented machine-learning-based variable-rate spraying, adjusting pesticide flow dynamically according to crop type and density [8]. Hejazipoor et al. (2021) designed a robot capable of adjusting spray rate based on plant bulk volume using ultrasonic sensors, improving uniformity across varying crop densities [9]. Kayode et al. (2024) developed a solar-powered, remote-controlled sprayer vehicle, demonstrating the feasibility of

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renewable energy for field spraying while minimizing chemical exposure [10]. While these studies demonstrate significant technological progress, several limitations remain. Many systems still require manual effort or operator supervision. Direct farmer exposure to hazardous chemicals continues in many cases. Advanced autonomous systems are expensive, limiting accessibility for small-scale farmers. Few affordable solutions integrate renewable energy, automation, and multi-nozzle spraying technology. Hence, there is a substantial need for a low-cost, automated, solar-powered sprayer robot that can operate efficiently in Indian rural farming conditions.

The present study aims to develop a solar-powered automatic sprayer robot to reduce labor requirements and manual effort in pesticide application, minimize direct human exposure to hazardous chemicals, improve spraying uniformity and operational productivity, and provide an economically viable solution suitable for small and marginal farmers. The specific objectives of this research are to design and fabricate a solar-powered pesticide sprayer with multi-nozzle capability, ensure operator safety by preventing exposure to harmful chemicals, and enable navigation and control of the machine through Bluetooth or wireless remote systems. By addressing these objectives, the proposed system seeks to bridge the gap between high-cost mechanized spraying solutions and inefficient manual sprayers, offering a sustainable, affordable, and efficient alternative for India’s agricultural sector

II. METHODOLOGY

The proposed system is designed to automate pesticide spraying for small and medium-scale agricultural operations using a solar-powered robotic platform. The methodology integrates mechanical, electrical, and control subsystems to achieve remote-controlled spraying with enhanced coverage, reduced human effort, and improved safety. The system comprises major components including DC motors, a rechargeable battery, a structural frame, a multi-nozzle sprayer, motor drivers, a control unit, wheels, and a chemical storage tank.

2.1 System Architecture

The robotic sprayer is constructed on a four-wheel mechanical base frame that provides structural support for all mounted components. The schematic diagram of android operated solar-powered automatic disinfectant sprayer robot is shown in the Figure1. The wheels are driven by DC motors connected to motor drivers, enabling controlled forward, reverse, and turning movements. A dedicated DC motor powers the pump, which pressurizes the liquid pesticide stored in the onboard tank. The overall system architecture ensures coordinated functioning of the drive mechanism, spraying setup, and control electronics. All components are compactly arranged on the chassis to maintain weight balance and operational stability, even on uneven agricultural terrain.

The spraying mechanism consists of a chemical storage tank, pump, distribution pipes, and a multi-nozzle assembly. The tank stores the pesticide solution and supplies it to the pump. When activated, the pump delivers pressurized liquid through a network of pipelines connected to multiple nozzles. The multi-nozzle configuration is strategically positioned to maximize coverage on both sides of the crop rows, ensuring uniform pesticide distribution, reducing spraying time, and minimizing chemical wastage. The design also allows adjustment of nozzle angles according to crop height and field conditions, enhancing versatility and efficiency.

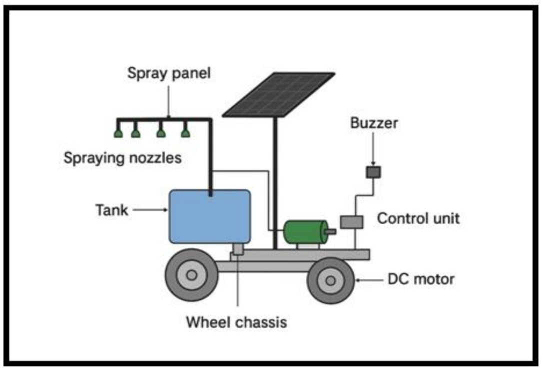

Figure1. The schematic diagram of android operated solar-powered automatic disinfectant sprayer robot

2.2 Control Unit

The movement and spraying operations of the robot are managed through a wireless control system, which may include a remote-control module or a Bluetooth-based interface. The control unit sends commands to the motor drivers that operate both the wheel-driving DC motors and the pump motor. This remote-control capability allows the operator to navigate the robot, start or stop spraying, and adjust movement direction from a safe distance, thereby reducing exposure to harmful chemicals and improving operator safety.

2.3 Power Supply System

The robotic sprayer is powered primarily by a rechargeable battery that supplies electricity to the drive motors, pump, and control electronics. To ensure continuous operation in the field, the battery is integrated with solar panels mounted on the chassis. These panels provide real-time charging, reducing reliance on external electrical sources and lowering operational costs. The integration of solar energy not only makes the system sustainable but also ensures that it can operate in rural areas with inconsistent electricity supply.

2.4. Working Methodology

The operation of the proposed robotic sprayer is based on the fundamental principle of electromagnetism, which governs the working of DC motors. A straight conductor placed in a magnetic field experiences no force when it carries no current. However, when current flows through the conductor, the magnetic fields interact, causing the flux density to increase on one side and decrease on the other. This imbalance generates a force that moves the conductor in a specific direction. Reversing the current reverses the direction of rotation, a principle that is harnessed to generate torque in DC motors and enables precise control of the robot's movement.

Each wheel of the robot is independently driven by a 30 RPM DC motor, allowing smooth, controlled, and coordinated movement across the field or surface area. The mobility system is supported by motor drivers that regulate current to the DC motors based on commands received from the control unit. This arrangement enables forward, reverse, and turning motions, ensuring the robot can navigate tight spaces or uneven terrain efficiently.

The spraying system operates through a DC-powered pump, which draws the liquid pesticide or disinfectant from the onboard storage tank and delivers it to the multi-nozzle assembly. The height and angle of the spray can be adjusted depending on crop type, surface conditions, or specific disinfection requirements. For disinfection purposes, the robot atomizes the liquid into fine droplets, enabling efficient coverage of surfaces. For example, with a 1-liter tank, the robot can spray a strip up to 4 feet wide and reach a range of 60–70 feet, depending on its operating speed.

The robot is controlled remotely using an Android mobile application via Bluetooth, allowing the operator to start or stop spraying, navigate the robot, and adjust spraying parameters from a safe distance. This wireless control system minimizes direct human exposure to harmful chemicals, ensuring safety during pesticide application or disinfection operations. The autonomous yet operator-guided functionality makes the robot highly suitable for deployment in small or medium-scale farms, public spaces such as metro trains, pathways, malls, and other areas where human exposure must be minimized.

Overall, the integration of DC motor-driven mobility, pump-operated spraying, adjustable nozzle configurations, and Bluetooth-based remote control enables efficient, uniform, and safe pesticide application or disinfection, addressing the key challenges faced by conventional manual spraying methods.

III. RESULTS AND DISCUSSION

The automatic pesticide spraying robot was successfully developed and tested under controlled and field conditions. The experimental results demonstrate that the system is efficient, safe, and practical for small- and medium-scale agricultural operations as well as disinfection applications in public areas. When powered by the rechargeable battery, the DC motors independently drive all four wheels, providing smooth, stable, and controlled movement. Simultaneously, the DC pump delivers a continuous spray of pesticide or disinfectant through multiple nozzles, ensuring uniform distribution across the target area.

The Bluetooth-controlled interface allows the robot to be operated remotely up to a distance of 50 meters, significantly reducing operator exposure to harmful chemicals. This feature enhances safety while allowing precise control over robot navigation and spraying functions. Testing confirmed that the robot is capable of covering large areas in a short time, thereby reducing labor requirements and operational time compared to conventional hand-operated or motorized backpack sprayers.

The adjustable nozzle height ensures consistent spray coverage across various crop heights and surface conditions, including narrow or hard-to-reach areas such as pathways, metro trains, buses, and other public spaces. The nozzle flow rate was measured as 0.79 liters per minute per nozzle. With four nozzles in operation, the total spray output reaches 3.16 liters per minute, providing efficient and uniform pesticide application. Furthermore, the system was observed to maintain adequate pump pressure even when the robot temporarily stops due to track resistance or obstacles, ensuring uninterrupted spraying.

Overall, the results highlight the robot's operational efficiency, safety, and reliability. Compared to traditional spraying methods, the proposed system significantly reduces manual labor, enhances coverage uniformity, and minimizes chemical exposure to operators. The combination of solar-powered battery operation, multi-nozzle spraying, and wireless control demonstrates the practical feasibility of deploying low-cost, automated spraying solutions in Indian agricultural conditions as well as for urban disinfection applications. The study confirms that the integration of automation, renewable energy, and remote operation can provide a sustainable, safe, and effective alternative to conventional pesticide application methods.

IV. CONCLUSION

The solar-powered automatic pesticide spraying robot developed in this study successfully addresses key challenges faced by small- and medium-scale farmers. The system demonstrates efficient, uniform pesticide distribution with adjustable nozzle height, smooth mobility, and remote operation up to 50 meters, ensuring minimal human exposure to harmful chemicals. The multi-nozzle configuration allows rapid coverage of large areas, significantly reducing labor and operational time compared to conventional manual sprayers. Integration of rechargeable batteries with solar panels provides a sustainable and reliable power source, making the system suitable for rural environments with inconsistent electricity supply. Overall, the robot offers a safe, cost-effective, and practical solution for precision pesticide application, improving productivity and operational safety in agricultural and public disinfection applications. The results validate the feasibility of combining automation, renewable energy, and remote-control technology to enhance efficiency and safety in pesticide spraying.

REFERENCES

[1] F. P. Terra et al., "Autonomous Agricultural Sprayer using Machine Vision," Journal of Intelligent & Robotic Systems, 2021.DOI: https://link.springer.com/article/10.1007/s10846-021-01361-x

[2] F. E. Nasir et al., "Precision agricultural robotic sprayer with real-time plant recognition and variable-rate application," Sensors, 2023.DOI: https://pmc.ncbi.nlm.nih.gov/articles/PMC10065285/

[3] H. Hejazipoor et al., "An intelligent spraying robot based on plant bulk volume," Computers and Electronics in Agriculture, Elsevier, 2021. DOI:https://www.sciencedirect.com/science/article/abs/pii/S0168169920313429

[4] J. F. Kayode et al., "Development of remote-controlled solar-powered pesticide sprayer vehicle," Discover Applied Sciences, Springer, 2024. DOI:https://link.springer.com/article/10.1007/s42452-024-05748-x

[5] R. Rai, "Sustainable Solar Powered Multi Nozzle Pesticide Sprayer," International Journal of Progressive Technology and Engineering, 2024. DOI:https://ijpste.com/index.php/ijpte/article/view/69

[6] "A Comprehensive Review on Agriculture-Based Pesticide Spraying Robot," ResearchGate, 2023. DOI:https://www.researchgate.net/publication/374150107

[7] "Bluetooth Based Agrobot Used to Spray the Pesticides," International Journal for Research in Applied Science and Engineering Technology (IJRASET). DOI:https://www.ijraset.com/research-paper/bluetooth-based-agrobot-used-to-spray-the-pesticides

[8] M. Tahmasebi et al., "An Autonomous Pesticide Sprayer Robot with a Color-Based Weed Detection System," International Journal of Robotics and Control Systems, 2022.DOI:

https://pubs2.ascee.org/index.php/IJRCS/article/view/480

[9] N. T. A. Nguyen et al., "Development of a line-following autonomous spraying vehicle for greenhouse applications," Computers and Electronics in Agriculture, Elsevier, 2023. DOI:https://www.sciencedirect.com/science/article/pii/S0168169923008177

[10] "Smarter Robotic Sprayer System for Precision Agriculture," ResearchGate, 2025. DOI:https://www.researchgate.net/publication/357834427