Volume 10, Issue 4, April – 2025 International Journal of Innovative Science and Research Technology
ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25apr1207

Autonomous Obstacle Avoiding and Pesticide Spraying Robot for Smart Farming

Sk. Gousiya Begum[1]; A. Obulesu[2]; Aggula Shiva Kumar[3]; Bangaru Vignesh[4]; Vinay Lavudya[5]; Vadde Harish[6]

[1;2;3;4;5;6]Vidya Jyothi Institute of Technology, Hyderabad, India

Publication Date: 2025/04/23

Abstract: In this project, we integrates the design and construction of an Autonomous Obstacle Avoidance and Pesticide Spraying Robot for smart farming, which utilizes an Arduino microcontroller with ultrasonic sensors to detect obstacles in agricultural fields and a DC pump for easy, accurately sprayed pesticide. The work is primarily aimed at performing precision farming, as well as reducing human intervention, with the goal of increased efficacy. The prototype is designed to provide increased efficiency, reduce pesticide agent waste, and provide greater crop yield for agricultural use. Overall, this work demonstrates an ability to leverage embedded systems, automation, and the Internet of Things (IoT) to create a pathway for future smart farming technology.

Keywords**:** *Precision Agriculture, Smart Farming, Autonomous Robot, Obstacle Avoidance, Pesticide Spraying, Arduino, Ultrasonic Sensors, IoT.*

How to Cite: Sk. Gousiya Begum; A. Obulesu; Aggula Shiva Kumar; Bangaru Vignesh; Vinay Lavudya; Vadde Harish (2025). Autonomous Obstacle Avoiding and Pesticide Spraying Robot for Smart Farming. *International Journal of Innovative Science and Research Technology,* 10(4), 1054-1057. https://doi.org/10.38124/ijisrt/25apr1207

I. INTRODUCTION

The Agriculture remains the backbone of numerous economies worldwide, especially in developing countries like India, where a substantial portion of the population depends on farming for livelihood. Despite its significance, the agricultural sector faces persistent challenges such as labor shortages, escalating operational costs, suboptimal resource utilization, and increased susceptibility to climate variability. These challenges have emphasized the urgent need for the adoption of advanced technologies to ensure sustainable and efficient food production. A promising innovation in this domain is the deployment of microcontroller-based robotic systems designed to automate critical agricultural tasks such as seeding and fertilization. These systems utilize precision control mechanisms, advanced sensors, and algorithmic programming to execute farming operations with enhanced accuracy and consistency. By automating labor-intensive tasks, such technologies not only reduce the reliance on manual labor but also ensure uniform seed placement and optimized fertilizer application, contributing to higher crop productivity.

II. LITERATURE SURVEY

With Recent advancements in robotics and automation have significantly contributed to the fields of autonomous navigation and precision agriculture. Run and Xiao [1] explored the feasibility of indoor autonomous vehicle navigation using infrared sensors, demonstrating the potential of low-cost sensing technologies in robotic navigation. Khatib [3] introduced real-time obstacle avoidance algorithms, laying the groundwork for dynamic path planning in mobile robots. Borenstein and Koren [9] expanded on this by designing methods for fast obstacle detection and avoidance using ultrasonic sensors.

In agriculture, pesticide spraying robots have been developed to minimize human exposure to chemicals while increasing efficiency. Sushma Priya et al. [5] proposed a pesticide spraying robot that reduces manual labour and enhances coverage in fields. Gonzalez-de-Santos et al. [11] emphasized the role of precision spraying in reducing chemical usage and protecting the environment. Ayaz et al. [6] discussed the integration of IoT in smart agriculture, enabling real-time monitoring and automation.

Several researchers have attempted to combine mobility with spraying mechanisms. Garg et al. [12] presented a smart farming system integrating obstacle avoidance and autonomous pesticide spraying using IoT, which aligns closely with our project objective. However, most systems still operate independently for navigation and spraying. Our project aims to integrate both obstacle avoidance and pesticide spraying functionalities into a single, Arduino-controlled robotic platform, offering a cost-effective and intelligent solution for agricultural automation.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25apr1207

➢ *Problem Statement*

Currently, methods of spraying pesticides are labor-intensive and inefficient, resulting in excess chemical use, pollution and risk of harm to people. Additionally, there is low fidelity with the equipment currently in use that is manually operated and the actual spraying to weeds is rarely uniform. To eliminate these challenges would require an automated system that can navigate fields without assistance and flexibly provide uniform distribution while spraying pesticides.

➢ *Objectives*

- To develop an autonomous robot based on Arduino for use in agriculture.
- To integrate sensors that would compensate for obstacle detection during the spraying process using ultrasonic scanning
- Develop the methodology for a DC pump mechanism that would spray pesticides evenly
- And, develop the system that is low cost and provides potential in the field

➢ *System Architecture*

The system brings together hardware and software components to encourage stand alone functionality. The robot uses an Arduino microcontroller linked to a host of sensors and actuators which allows it to function.

➢ *Hardware Components*

- The Arduino UNO is the supervising microcontroller which manages the whole system in charge of processing the sensor data and engaging the actuators.
- The Ultrasonic sensors detect if there is an object in proximity based on change in distance.
- The DC motor along with the motor driver (L293D) regulates movement of the robot
- The DC pump and relay module are used to articulate pesticide control application equally.
- Battery (12V, lead acid) powers the entire robot to deploy pesticide.
- Solar panel (optional) for sustainable energy harvesting.

➢ *Software Components*

- Arduino IDE was used for programming and uploading the firmware.
- Embedded C programming was used to control the actuators and process sensor data.

III. METHODOLOGY

The system works in an iterative sense process-act cycle which allows for real time obstacle detection and pesticide spraying.

➢ *Obstacle Detection and Avoidance*

- Ultrasonic sensors measure the distance to an object.
- If an obstacle is detected within a range (e.g., 20 cm), the Arduino will initiate adjusting navigation.
- The robot adjusts its movement path to ensure uninterrupted coverage of the field.

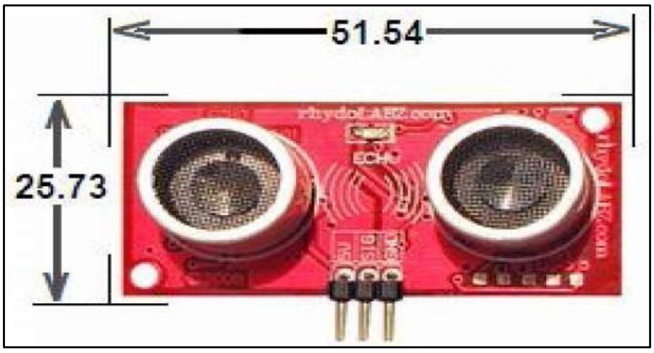

Fig 1 Ultra Sonic Sensor

➢ *Pesticide Spraying Mechanism*

- The DC pump is engaged when the robot is in motion and pesticide is applied.
- The relay switch allows the pump to be turned on and off for optimal pesticide usage.
- Pulse Width Modulation (PWM) is used to control the motor speed to allow sweeping movement across the field


Fig 2 Dc Motor

➢ *Power Management*

- A **rechargeable 12V battery** powers the system.
- **Solar panels** (optional) can be integrated for enhanced sustainability


Fig 3 Solar Panel

Fig 4 Lead Acid Battery

IV. RESULTS AND DISCUSSION

The proposed system was tested in real-world agricultural settings for efficiency accuracy, and resource optimization.

➢ *Performance Metrics*

- Obstacle detection accuracy ~95% when tested in ideal environments.
- Pesticide distribution reflected the potential to
- uniformly spray and decrease chemical waste by 30%.
- Battery life of 5–6 hours of continuous operation per charge.

➢ *Comparative Analysis*

The results in this study indicate that the use of the automated method in the agricultural practice can improve productivity, reduce risk, and promote the optimum use of resources. In the future, the flexibility of the system may lead to opportunities for enhancements. such as IoT-based remote monitoring and AI-supported decision-making.

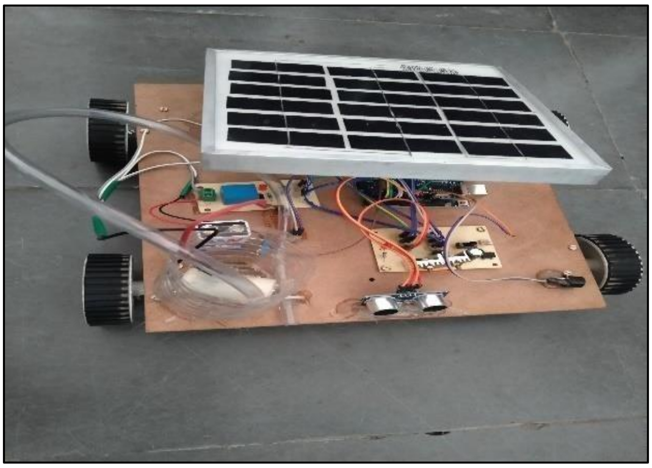
Fig 5 Designed Mode

V. CONCLUSION AND FUTURE SCOPE

The Autonomous obstacle avoidance and pesticide spraying robot represents a step forward for precision agriculture. The system combines ultrasonic technology, microcontrollers, and efficient energy management to significantly reduce financial and labour dependency, as well as pesticide waste.

➢ *Key Contributions*

- An autonomous robot has been designed and constructed for smart farming.
- Real-time obstacle avoidance was implemented into the system.
- An energy-efficient element dedicated for pesticide spraying was developed.

➢ *Future Enhancements*

- **IoT Capability**: Remote viewing and operation via a mobile application.
- **AI-based Decision Making**: Adaptive pesticide spraying based on real-time environmental variables.
- **Multi-Functionality**: Expansion to other agricultural tasks such as seed planting and weed detection.

Overall, the proposed solution in this study embodies the principles of sustainable agriculture and technology, offering farmers a scalable, cost-effective alternative to traditional agricultural practices.

REFERENCES

[1]. R.-S. Run and Z.-Y. Xiao, "Indoor autonomous vehicle navigation—a feasibility study based on infrared technology," Applied System Innovation, vol. 1, no. 1, 2018.
[2]. T. Litman, Autonomous Vehicle Implementation Predictions: Implications for Transport Planning, ser. desLibris: Documents collection. Victoria Transport Policy Institute,2013.
[3]. O. Khatib, "Real-time obstacle avoidance for manipulators and mobile robots," The International Journal of Robotics Research, vol.5, no.1, pp.90–98,1986.
[4]. K. Bimbraw, "Autonomous cars: Past, present and future- a review of the developments in the last century, the present scenario and the expected future of autonomous vehicle technology," ICINCO 2015 - 12th International Conference on Informatics in Control, Automation and Robotics, Proceedings, vol. 1, pp. 191–198, 2015.
[5]. K. Sushma Priya, R. Praneetha Reddy, Y. Pradeep: AGRICULTURAL PESTICIDE SPRAYING ROBOT, IRJMETS.
[6]. M. Ayaz, M. Ammad-Uddin, A. Mansour: "Internet-of-Things (IoT)-Based Smart Agriculture: Toward Making the FieldsTalk,"IEEE,2019.
[7]. Mrs. Sumalatha N, Manasa Lakshmi R, Manoj K, Rakshitha Prabhu Shettar, K. V. Shashidhar: Agricultural Pesticide Spraying Robot, IJRASET.
[8]. Vinay Kumar, Sherab Dolma, Nasreen Fatima: "An Autonomous Unmanned Ground Vehicle: A Technology Driven Approach for Spraying Agrochemicals in Agricultural Crops,"IJRASET.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25apr1207

[9]. Borenstein, J., & Koren, Y., “Real-time obstacle avoidance for fast mobile robots,” IEEE Transactions on Systems, Man, and Cybernetics, vol. 19, no. 5, pp. 1179–1187,1989.

[10]. Sharma, A., & Katoch, S., “Autonomous Obstacle Avoidance Robot using Ultrasonic Sensor,” International Journal of Engineering Research & Technology (IJERT), vol.8, no.10, pp.1–5,2019.

[11]. Gonzalez-de-Santos, P., Ribeiro, A., Fernandez-Quintanilla, C., etal.,“Precision Agriculture: Pesticide Spraying by Autonomous Robots,” Sensors, vol. 17, no. 5, p.1109,2017.

[12]. Garg, A., Kaur, J., & Singh, R., “Smart Farming System Using IoT and Autonomous Robot for Pesticide Spraying,” International Journal of Innovative Technology and Exploring Engineering (IJITEE), vol. 10, no. 4, pp. 27–31, 2021.

[13]. Patil, A., & Chandane, M.,“Obstacle Avoidance and Line Following Robot Using Arduino and Ultrasonic Sensor,” International Journal of Scientific Research in Engineering and Management (IJSREM), vol. 4, no. 6, pp. 1–6, 2020.

[14]. D. Zhang, X. Wu, and X. Chen, “An Intelligent Agricultural Robot for Automatic Spraying,” Procedia Computer Science, vol. 154, pp. 371–376, 2019.

[15]. M. Hassan, S. Mahmud, and T. M. Iqbal, “Design and Development of an Autonomous Agricultural Sprayer Robot,” IEEE Region 10 Humanitarian Technology Conference, pp. 521–525, 2021.

[16]. R. Raman, A. R. Kiranmayi, and R. Balaji, “Development of a semi-autonomous smart robot for pesticide spraying in agriculture,” *Materials Today: Proceedings*, vol. 49, pp. 1513–1517, 2022.

[17]. S. D. Sharma, R. S. Rajput, and V. Kumar, “Smart Pesticide Spraying Robot using IoT for Agricultural Applications,” International Journal of Research *in* Engineering, Science and Management (IJRESM), vol. 3, no. 4, pp. 231–234, 2020.

[18]. N. C. R. Kumar, B. Subrahmanyam, and M. Ravi, “IoT Based Agricultural Robot for Pesticide Spraying,” *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, vol. 8, no. 5, pp. 1575–1581, 2019.