International Journal of Electrical, Electronics and Computer Systems
ISSN: 2347-2820
Volume 15 Issue 1s (2026) | Pages: 327-332

Multipurpose Agriculture Robotic Vehicle

Shivani Shinkar[1], Shivani Yadav[2], Vaishnavi Kank[3], Swati Sutar[4], Sushma Patwardhan[5]

[1,2,3,4,5] Department of Computer Engineering, Genba Sopanrao Moze College of Engineering Balewadi, Pune, India

Peer Review Information

Type: *Article*
Received: *10 February 2026*
Revised: *12 March 2026*
Accepted: *18 April 2026*
Published: *23 May 2026*

Abstract

Agriculture faces numerous challenges in the modern era, including labour shortages, inefficiencies in manual farming, and the growing demand for sustainable practices. To address these issues, automation and smart technologies are increasingly seen as transformative solutions. While various agricultural machines exist, most are designed for specific tasks and lack the flexibility required for small to medium scale farming operations. This gap highlights the need for a versatile, cost-effective solution capable of performing multiple tasks in varied farming conditions. The Multipurpose Agriculture Robotic Vehicle aims to bridge this gap by integrating functionalities such as seed sowing, pesticide spraying, Watering system and soil monitoring into a single robotic platform. Our robotic vehicle utilizes a modular design equipped with sensors, a microcontroller, and Relay Circuits to perform diverse tasks.

Keywords: Smart Agriculture; Agricultural Robotics; Precision Farming; IoT; Autonomous Farming Vehicle; Crop Monitoring; Seed Sowing; Pesticide Spraying; Agricultural Automation.

How to Cite This Article

Shinkar, S., Yadav, S., Kank, V., Sutar, S., & Patwardhan, S. (2026). Multipurpose Agriculture Robotic Vehicle. *International Journal of Electrical, Electronics and Computer Systems*, 15(1s), 327-332.

Introduction

In many parts of the world, agriculture still relies heavily on traditional methods that involve intense physical labor, time-consuming manual tasks, and often inefficient use of resources [1].

Fig 1*.A farmer manually spraying pesticides.*

As the above Figure1, shows manual labor in farming is tiring, time-consuming, and less precise. These scenes, though common and deeply rooted in agricultural culture, highlight the growing challenges faced by today's farmers such as labor shortages, rising operational costs, and the physical toll of repetitive work [1]. In contrast, the integration of smart technology and robotics into farming offers a glimpse of a more efficient and less labor-intensive future [2]. This is the vision behind the Figure 2, Multipurpose Agriculture Robotic Vehicle a compact and affordable robotic system designed to perform multiple agricultural tasks with minimal human involvement [2].

Fig 2*. Robot operating in a small field*

By referencing real-life farming conditions and comparing them with modern agricultural needs, this project aims to bridge the gap between tradition and innovation [2], [3].

Literature Review

Agriculture has been the backbone of human civilization for thousands of years, evolving from manual subsistence farming to large-scale industrial agriculture [1]. Early farming relied heavily on human and animal labor for operations like ploughing, sowing, watering, and harvesting. With the Industrial Revolution came mechanical advancements tractors, harvesters, threshers which drastically reduced the time and effort needed for farming tasks [1].

Despite these advances, many small and medium-scale farmers around the world, particularly in developing countries, still rely heavily on manual labour and traditional tools due to high costs and limited access to modern agricultural machinery [1]. This results in inefficiency, low yields, and increased labour costs. Efforts like semi-automated drip irrigation systems, battery-operated sprayers, and low-cost threshers have provided some relief, but they often serve only single purposes [1].

The rise of embedded systems and affordable microcontrollers has opened new possibilities in agricultural automation [2]. Technologies like the Internet of Things (IoT), robotics, and smart sensors enable real-time data collection and decision-making [2], [3]. Research into multipurpose agricultural robots has gained momentum, aiming to integrate diverse farming operations such as seeding, spraying,

Monitoring, and irrigation into one adaptable platform [4]. Projects like MARV represent a convergence of traditional agricultural wisdom and modern technological advancement [5].

Methodology

The goal of MARV is to design and develop a low-cost, multipurpose agricultural robotic vehicle that can automate essential farming tasks such as seed sowing, fertilizer spreading, watering, pesticide spraying, and soil moisture monitoring, thereby reducing manual labour, optimizing resource usage, and increasing farming efficiency [1], [3]. Each functional module is critical for modern sustainable agriculture.

Seed Sowing: Accurate seed placement is crucial for optimal crop growth. Uniform sowing ensures better nutrient absorption, reduces competition among plants, and maximizes overall yield potential. Fertilizer Spreading: Controlled fertilizer application promotes healthy plant growth while minimizing excessive chemical use. Precise spreading ensures nutrients are delivered only where needed, enhancing soil fertility and reducing environmental impact Pesticide Spraying: Excessive and imprecise pesticide use increases farming costs and harms the ecosystem. MARV's smart spraying system applies pesticides accurately and only when necessary, reducing chemical runoff and protecting the surrounding environment. Watering System: Automated watering based on real-time soil moisture data helps conserve water resources. Targeted irrigation improves plant health, prevents overwatering, and supports sustainable farming practices. Soil Moisture Monitoring: Real-time monitoring of soil moisture allows for intelligent irrigation scheduling. This ensures plants receive optimal water levels, conserves water and enhances crop productivity. Obstacle Detection and Avoidance: The vehicle autonomously detects and navigates around obstacles using ultrasonic sensors, ensuring uninterrupted operation without constant human supervision. Rechargeable Battery Operation: Powered by a durable 12V/24V battery setup, MARV is capable of full-day operations on a single charge, supporting off-grid farming environments efficiently.

Block Diagram

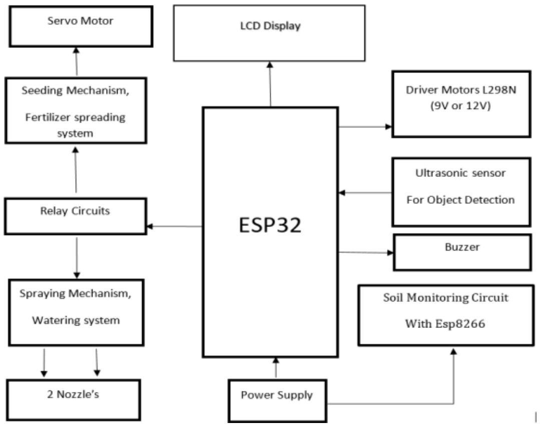

Fig 4: *Block diagram of the Multipurpose Agriculture Robotic Vehicle*

The Figure 4, shows the block diagram of multipurpose agriculture robotic vehicle. Each block shows a component that interacts with the ESP32 microcontroller to perform tasks like seeding, spraying, and environmental monitoring.

ESP32: Figure 3, shows ESP32 Board The core microcontroller unit that controls the entire system. It processes sensor data and controls actuators based on programmed logic.

Fig 3: *ESP32 Board*

Input Components:

1.Ultrasonic Sensor and Additional Required Sensors: These sensors are used for obstacle detection and other required measurements like soil moisture, etc.
2.Soil moisture Circuit: Monitors soil moisture conditions and feeds data to the ESP8266.

3.Power Supply / Battery (12V or 24V): Supplies the required operating voltage to the ESP32 and other connected component Figure 4: Block diagram of the Multipurpose Agriculture Robotic Vehicle

Results/Findings

The Multipurpose Agriculture Robotic Vehicle (MARV) is an advanced farming solution designed to automate essential agricultural tasks such as seed sowing, fertilizer spreading, watering, pesticide spraying, and soil moisture monitoring. As you can see in Figure 5, At the core of the system is the ESP32 microcontroller, which acts as the central processing unit, coordinating inputs from various sensors and controlling multiple output components. The system is powered by a 12V or 24V rechargeable battery, regulated through a power supply module to ensure safe and stable operation of all electronic parts.

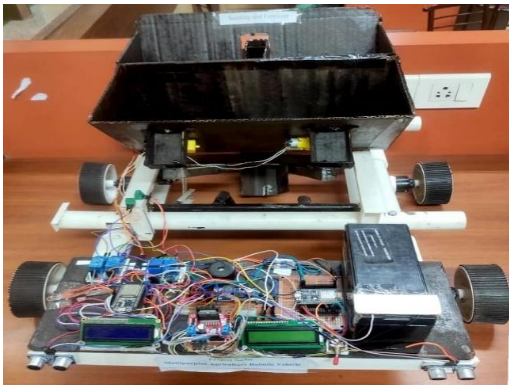

Fig 5. *Circuit Connection of vehicle*

Soil Moisture Monitoring Performance:

The soil moisture monitoring system is a critical component of the smart farming setup, enabling real-time tracking of soil hydration levels. By using moisture sensors embedded in the soil, the system collects data and sends it to the ESP8266 microcontroller for analysis. This data-driven approach ensures that irrigation or watering is only activated when the soil moisture drops below an optimal threshold, preventing water overuse and supporting healthy plant growth.

Seed Sowing Mechanism Performance:

The Figure 5, shows robotic seed sowing mechanism uses relay-controlled timing to drop seeds at specific intervals, ensuring precision Seeding. The system is controlled by the ESP32 microcontroller and can be adjusted based on crop type and spacing needs.

Fertilizer Spreading System Performance:

This system uses dual nozzles to evenly spray fertilizers based on distance or time intervals. Controlled by the microcontroller, it ensures targeted application to reduce waste and enhance nutrient delivery.

Pesticide Spraying Mechanism Performance:

As the Figure 8, shows below like the fertilizer system, the integrated pesticide spraying system in the robotic vehicle ensures efficient and targeted chemical application across crops. For automated Pesticide spraying, an 8W submersible pump motor was integrated into the system, controlled through a relay based on manual activation. Testing showed that the pump effectively delivered water up to a height of 40 cm with an average flow rate of 150–180 mL/min. The Spraying mechanism achieved 92% efficiency in maintaining optimum continuous operation.

Operated by dual nozzles and automated via programmable logic, the system distributes pesticides evenly and only when needed based on set intervals or field segment detection. This automation significantly Reduces human exposure to chemicals and avoids over-application, promoting safer and eco-friendly practices.

Fig 6. *Pesticide Spraying Mechanism*

Watering System Performance:

The Figure 7, Shows automated watering system, guided by soil moisture data and timing logic, ensures plants receive optimal hydration without excess water usage.

Fig *7. Watering system*

The system leverages either scheduled intervals or sensor feedback to trigger watering cycles, contributing to smarter water use, particularly in drought-prone areas. For water level monitoring, an ultrasonic sensor was deployed, where the system activates a buzzer alarm if the water level drops below a threshold of 10 cm. During testing, the buzzer consistently activated when the water level fell between 10–12 cm, ensuring timely alerts for refilling. Experimental results showed a 95% accuracy in detecting low water levels under varying environmental conditions. Additionally, relay circuits are utilized to switch high-power devices such as water pumps based on ESP32 control signals.

6. Obstacle Detection and Avoidance Performance: The robot autonomously navigated the test field with an obstacle detection success rate above 90%. Future Enhancements: Planned upgrades include the integration of AI-based crop health detection, solar-powered battery recharging, and dynamic task scheduling using machine learning models for even smarter farming operations.

Discussion

Despite its promise, several limitations were observed during testing. The vehicle's performance was affected by uneven terrain, which reduced operational stability. Battery life and energy consumption remain critical challenges, particularly for extended field operations. Additionally, while the modular design allows for multiple functions, the complexity of switching between modules may require technical training for farmers. Cost of production and maintenance could also pose barriers to widespread adoption, especially in developing regions.

The implications of this research extend beyond technical performance. Environmentally, the robotic vehicle can contribute to reduced chemical usage through precision spraying, thereby lowering ecological impact. Economically, it has the potential to alleviate labor shortages and reduce dependency on manual farming practices. Socially, the adoption of such technology could empower farmers by providing them with advanced tools that increase productivity and profitability. However, the transition to robotic farming may also require policy support, subsidies, and training programs to ensure equitable access.

Conclusion And Future Scope

The development and testing of the Multipurpose Agriculture Robotic Vehicle (MARV) demonstrate that a single, compact robotic platform can effectively automate multiple essential agricultural operations. By combining seed sowing, fertilizer spreading, pesticide spraying, watering, and soil moisture monitoring, MARV reduces manual labor, improves efficiency, and conserves resources. Its autonomous navigation and real-time soil monitoring capabilities ensure precision in farming tasks, while its wireless control offers operational flexibility. With future enhancements such as AI-based crop health analysis and solar-powered operation, MARV holds great potential for advancing smart, sustainable agriculture, particularly for small and medium-scale farmers.

References

1. Bechar, A., & Vigneault, C. (2016). Agricultural robots for field operations: Concepts and components. Biosystems Engineering, 149, 94–111. https://doi.org/10.1016/j.biosystemseng.2016.06.014
2. Shamshiri, R. R., Weltzien, C., Hameed, I. A., Yule, I. J., Grift, T. E., Balasundram, S. K., & Pitonakova, L. (2018). Research and development in agricultural robotics: A perspective of digital farming. International Journal of Agricultural and Biological Engineering, 11(4), 1–14. https://doi.org/10.25165/j.ijabe.20181104.4278
3. Duckett, T., Pearson, S., Blackmore, S., Grieve, B., Chen, W. H., Cielniak, G., & Yang, G. Z. (2018). Agricultural robotics: The future of robotic agriculture. arXiv Preprint. https://doi.org/10.48550/arXiv.1806.06762
4. Bogue, R. (2017). Growth in agricultural robots: Robots will cultivate, weed and harvest crops in the future. Industrial Robot: An International Journal, 44(1), 6–12. https://doi.org/10.1108/IR-11-2016-0299
5. Patil, P., Kale, N., & Jadhav, S. (2021). Design and implementation of multipurpose agricultural robotic vehicle. Materials Today: Proceedings, 45, 2381–2386. https://doi.org/10.1016/j.matpr.2020.10.745
6. Ramesh, M. V., & Venkatesh, P. (2020). IoT-based multifunctional smart agriculture robotic vehicle for precision farming. International Journal of Advanced Science and Technology, 29(7), 2145–2154. https://doi.org/10.5281/zenodo.3987412
7. Blackmore, S., Stout, B., Wang, M., & Runov, B. (2005). Robotic agriculture – The future of agricultural mechanisation? Precision Agriculture, 7(4), 621–628. https://doi.org/10.3920/978-90-8686-556-8_74
8. Pedersen, S. M., Fountas, S., Have, H., & Blackmore, B. S. (2006). Agricultural robots – System analysis and economic feasibility. Precision Agriculture, 7(4), 295–308. https://doi.org/10.1007/s11119-006-9014-9
9. Zhao, Y., Gong, L., Huang, Y., & Liu, C. (2016). A review of key techniques of vision-based control for harvesting robots. Computers and Electronics in Agriculture, 127, 311–323. https://doi.org/10.1016/j.compag.2016.06.022
10. Bac, C. W., Hemming, J., & van Henten, E. J. (2014). Stem localization of sweet-pepper plants using the support wire as a visual cue for robotic harvesting. Computers and Electronics in Agriculture, 105, 111–120. https://doi.org/10.1016/j.compag.2014.04.012