International Journal of Scientific Research & Engineering Trends
Volume 11, Issue 5, Sept-Oct-2025, ISSN (Online): 2395-566X

# AUTONOMOUS ROBOTIC SYSTEM FOR EFFICIENT FARMING

[1] P Prakash, [2] Aakash K, [3]L Kannagi, [4]Amizhdhan L, [5]Pragathesh Kumar
Electronics and Communication Engineering Sri Sairam Engineering College Chennai, India
Computer and Communication Engineering Sri Sairam Institute of Technology, Chennai, India

**Abstract - This autonomous agricultural vehicle, equipped with a camera and GPS, is designed to optimize farming efficiency by automating critical tasks such as harvesting, weed removal, and pest control. The vehicle autonomously navigates through fields, reducing the reliance on manual labor while ensuring precise and timely execution of agricultural operations. For harvesting, the vehicle identifies and collects ripe crops efficiently, minimizing losses and enhancing overall productivity. In weed removal, it detects and eliminates unwanted plants, ensuring crops have access to nutrients without competition. For pest control, the vehicle monitors plant health and identifies areas affected by pests, applying treatments only where necessary. This targeted approach reduces pesticide use, contributing to eco-friendly and sustainable farming practices. With smart navigation and obstacle avoidance, the vehicle operates seamlessly in large and complex agricultural environments. By integrating automation into farming practices, this vehicle not only enhances productivity but also reduces costs, making it an essential component of modern precision agriculture.**

**Keywords: GPS, Camera, Ultrasonic sensor, Computer vision techniques, High precision, Lidar.**

## I. INTRODUCTION

In the evolving landscape of modern agriculture, the demand for automation in farming practices is increasing [1], driven by the need to improve efficiency, reduce costs, and meet the growing global food production challenges. The traditional farming model, which relies heavily on manual
labor, is facing several constraints, including labor shortages, rising operational costs, and environmental concerns such as excessive pesticide use. In response,

autonomous agricultural vehicles, equipped with advanced technologies such as computer vision, Global Positioning System (GPS), and machine learning, are emerging as a revolutionary solution to address these challenges.

The autonomous agricultural vehicle integrates a combination of camera-based computer vision and GPS-based navigation to carry out essential agricultural tasks such as harvesting, weed removal, and pest control. By navigating autonomously through the fields, the vehicle reduces the need for human intervention and ensures that operations are carried out more efficiently, precisely, and with greater consistency. The use of automation in farming allows for continuous and precise operations, enabling more productive farming practices.

Harvesting traditionally requires significant manual labor, with workers needing to identify, pick, and transport crops. The autonomous vehicle, however, utilizes real-time crop detection capabilities through computer vision algorithms. This allows itto recognize ripe crops based on attributes such as color, size, and shape. The vehicle efficiently collects crops, preventing losses due to late harvesting and enhancing overall productivity. Moreover, this automated
Weed removal is another labor-intensive task in agriculture, as weeds compete with crops for nutrients, water, and sunlight, negatively impacting crop yields. The autonomous vehicle equipped with advanced computer vision technology can identify and differentiate weeds from the crops, using machine learning techniques and color segmentation to pinpoint areas that require attention.
Once identified, the vehicle can then proceed to eliminate the weeds through mechanical means or precision-targeted herbicide application, ensuring crops receive the nutrients they need without competition. This reduces labor costs and enhances overall crop health and yield.

Pest control is a critical concern for crop health, and traditional pest management practices often involve blanket spraying of pesticides, which can result in the overuse of chemicals and environmental contamination. The autonomous vehicle addresses this issue by monitoring the health of crops using computer vision to detect early signs of pest damage. Once pests are detected, the vehicle applies treatments only to the affected areas, significantly reducing pesticide use. This targeted pest control approach minimizes chemical exposure to the environment, promoting eco-friendly and sustainable farming practices while ensuring effective pest management.
The autonomous agricultural vehicle is equipped with GPS and obstacle avoidance algorithms that allow it to navigate large

International Journal of Scientific Research & Engineering Trends
Volume 11, Issue 5, Sept-Oct-2025, ISSN (Online): 2395-566X

and complex agricultural fields efficiently. With the GPS module, the vehicle follows predefined routes with high accuracy, ensuring it moves through the fields in a structured and systematic manner. In addition, computer vision and LiDAR sensors provide real-time detection of obstacles such as trees, rocks, and other equipment. If an obstacle is detected, the vehicle dynamically adjusts its route, ensuring smooth and uninterrupted operation while avoiding damage to the vehicle or crops.

Fig :1 Prototype

By integrating these advanced technologies, the autonomous agricultural vehicle not only helps improve farming efficiency but also supports sustainable practices. It reduces the reliance on manual labor, cutting down on labor costs while boosting productivity. The targeted approach to pest control and weed removal minimizes the
need for chemical applications, contributing to a healthier environment and preserving natural resources.

## III. OBJECTIVE

Similar systems have been developed to reduce manual labor and improve efficiency [2] that can perform essential agricultural tasks, including harvesting, weed control, and pest management, while navigating autonomously using computer vision and GPS-based navigation. The system aims to enhance field efficiency by enabling the robot to work without human intervention, avoiding obstacles such as trees, rocks, and farm equipment using real-time obstacle avoidance capabilities.

Additionally, the project seeks to implement precision agriculture techniques that enable the robot to effectively identify and differentiate crops, weeds, and pests, optimizing the use of resources like water, fertilizers, and pesticides. The robot will be designed to detect ripe crops and carry out harvesting with precision, reducing crop loss and ensuring timely collection. Furthermore, it will promote eco-friendly farming practices by employing targeted pest control and weed management systems, minimizing chemical usage.

Another key objective is to incorporate energy-efficient technologies into the robot's design, ensuring long operational hours in large fields with minimal downtime for recharging. The project also involves developing localization and mapping technologies such as GPS, SLAM, or odometry to ensure the robot can map and navigate the farm layout autonomously, allowing for optimized path planning and better adaptability to changes in the environment.

A major focus is to provide a user-friendly interface that allows farmers to monitor and control the robot's operations remotely, offering real-time feedback on its tasks, status, and progress. The robot will also be evaluated based on its performance in real-world agricultural settings, with the goal of improving productivity, reducing labour costs, and optimizing overall farm management. Ultimately, the objective is to create an autonomous solution that contributes to sustainable farming practices, ensuring a balance between technological advancement and environmental responsibility.

## II. LITERATURE SURVEY

Bale, J. S., etal. (2014) – "Weed control using robotics: A review"
The adoption of autonomous robots in agriculture continues to evolve, with successful integration of GPS and AI for field tasks [3]. They highlighted advancements in vision-based weed detection systems and robotic platforms capable of autonomously distinguishing between crops and weeds. The authors discussed how active vision systems enable robots to adjust their perception of the environment, thereby achieving precise weed removal. A critical insight from the study is the integration of machine learning algorithms, which improve the accuracy of weed identification, allowing robots to target weeds specifically while avoiding crops. The study emphasizes that these systems significantly reduce reliance on herbicides, thus promoting more eco-friendly and cost-effective farming practices.

Fujita, M., et al. (2019) – "Development of an autonomous robot for harvesting tomatoes in greenhouses"
This paper by Fujita and colleagues presents the development of an autonomous robotic system for harvesting tomatoes in greenhouses. The robot is equipped with machine vision algorithms that enable it to detect ripe tomatoes based on factors such as color, size, and shape. The authors focus on the challenges of harvesting in confined greenhouse environments, where precision and minimal damage to plants is critical. The robot's ability to navigate autonomously within rows of crops, avoid obstacles, and selectively harvest only ripe tomatoes demonstrates its effectiveness in automated harvesting. The study also addresses the economic and practical implications of using autonomous robots for tasks traditionally handled by labor, such as harvesting, highlighting how these systems can reduce dependence on manual labor and improve harvesting efficiency in agricultural settings.

## IV. PROBLEM STATEMENT

The agricultural industry faces several challenges, including labor shortages, inefficient resource utilization, and the need for precision in farming practices [4], and the need for precision in farming practices. Traditional farming methods rely heavily on

human labor for tasks such as harvesting, weeding, and pest control, leading to high operational costs and inconsistent results. Furthermore, the overuse of chemicals and pesticides can harm the environment and reduce crop quality. To address these issues, there is a pressing need for an Autonomous Robotic System for Efficient Farming that can perform key agricultural tasks such as harvesting, weed management, and pest control with precision, reduced human intervention, and minimal environmental impact. This
system should be able to navigate fields autonomously, identify and select crops for harvesting, detect weeds, apply targeted pest control, and avoid obstacles without human guidance. Developing such a system will not only increase farm productivity but also support sustainable agricultural practices, reduce labor dependency, and minimize the adverse effects of pesticide use, ultimately transforming modern farming into a more efficient and eco-friendly industry.

## V. BLOCK DIAGRAM

The block diagram of the autonomous agricultural vehicle consists of four main sections: input sensors, processing unit, actuators and control systems, and output/data management. The input sensors include cameras (RGB, infrared, or thermal) for crop identification, weed detection, and pest monitoring, along with GPS for precise location tracking, LiDAR/ultrasonic sensors for obstacle detection, and environmental sensors (soil moisture, temperature, and humidity) for monitoring field conditions. The processing unit, comprising a microcontroller or microprocessor, integrates AI and machine learning models to analyze sensor data and make intelligent decisions for harvesting, weed removal, and pest control.

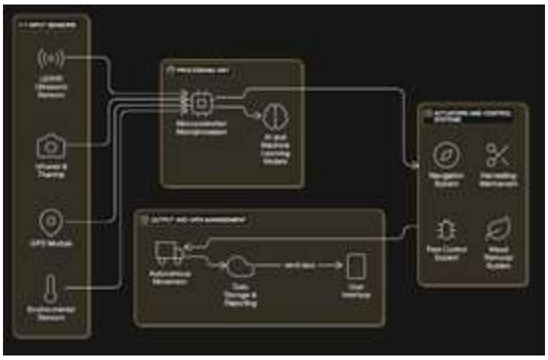

Fig 2: Block diagram

The actuators and control systems include a navigation system that ensures autonomous movement, a harvesting mechanism with robotic arms, a weed removal system using either mechanical or targeted herbicide application, and a pest control system for precise pesticide spraying. Finally, the output and data management system enable autonomous movement through GPS-based path planning, stores real-time data for analysis, and provides farmers with a user interface (remote dashboard or mobile app) for monitoring and controlling operations, enhancing efficiency and sustainability in precision agriculture.

## VI. PROPOSED SOLUTION

Such approaches have proven effective in previous robotic farming solutions [5] with high-precision GPS, LiDAR, and cameras for navigation, obstacle avoidance, and environmental monitoring. It employs advanced computer vision algorithms, including machine learning-based crop and weed detection, pest monitoring, and real-time localization for efficient task execution.

The vehicle autonomously performs tasks like harvesting, weed removal, and targeted pest control, utilizing robotic arms, mechanical weeding tools, and precision sprayers to reduce resource use and minimize pesticide applications. Powered by hybrid or lithium-ion batteries, it uses AI-driven decision-making for optimal task prioritization, ensuring eco-friendly, sustainable farming practices while reducing labor costs and increasing productivity. Data from the vehicle can be integrated with farm management systems for long-term analysis, enhancing overall farm efficiency

## VII. METHODOLOGY

The platforms used for the development of this project are:

- Camera
- GPS Module
- LiDAR Sensor
- Ultrasonic Sensor
- Microprocessor
- Arduino IDE
- Cloud-Based Data Storage

The development of the autonomous agricultural vehicle follows a structured methodology that integrates hardware, software, AI, and testing processes to enhance farming efficiency. The system consists of a robust all-terrain chassis, GPS for localization, and multiple sensors, including cameras for object detection, LiDAR/ultrasonic sensors for obstacle avoidance, and environmental sensors for field monitoring. The vehicle is powered by a microcontroller or microprocessor, which processes real-time data using AI and machine learning algorithms. These algorithms analyze images to detect ripe crops, weeds, and pests, optimizing harvesting, weed removal, and targeted pest control. The vehicle's actuators include a robotic arm for harvesting, a weed removal system for mechanical or chemical elimination, and a precision sprayer for minimal pesticide use. The software framework employs
GPS-based path planning, SLAM for real-time mapping, and sensor fusion for adaptive navigation. Embedded programming is done using Arduino IDE, while wireless connectivity enables remote monitoring, similar to Bluetooth-based agricultural robots [6] and data management, ensuring an efficient and scalable precision agriculture system.

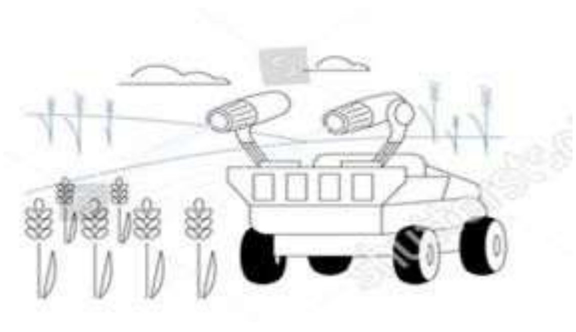

Fig 3: Pesticide spraying process

The autonomous agricultural vehicle executes its tasks with intelligent automation, reducing labor costs and promoting sustainability. It identifies and collects ripe crops efficiently while minimizing losses, detects and removes weeds to prevent nutrient competition, and monitors plant health to apply pest control measures only where necessary. The vehicle continuously adapts its path based on real-time sensor data, avoiding obstacles and optimizing field coverage. Before deployment, simulations using Proteus and field trials are conducted to validate performance, followed by iterative improvements based on real-world data and user feedback. Continuous refinement of AI models and system updates ensures long-term reliability and adaptability. By integrating smart automation, precision agriculture techniques, and eco-friendly practices, this vehicle significantly enhances productivity, reduces chemical usage, and supports sustainable farming.

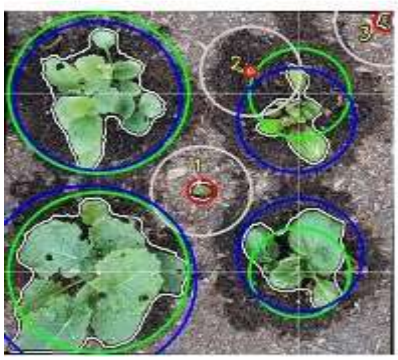

Fig 4: Weed detection

## VIII. CONCLUSION

The autonomous agricultural vehicle equipped with advanced sensors, AI-driven image processing, and precision control systems provides an efficient and intelligent solution for modern farming. By integrating computer vision, GPS-based navigation, and automated mechanisms for harvesting, weed removal, and pest control, the vehicle optimizes agricultural operations with minimal human intervention. These findings are consistent with prior implementations that demonstrated efficiency improvements using autonomous robotic systems [7] involved in developing such a system. The successful execution of this project demonstrates the potential of automation and AI in enhancing productivity, reducing costs, and promoting sustainable farming practices.

## REFERENCE

1. Autonomous Agricultural Monitoring Robot for Efficient Smart Farming” by Zubaidah Al-Mashhadan and Joon-Hyuk Park. (2023), IEEE.
2. Autonomous Agriculture Robot Sudipto Kar , Ragib Mohammad , Ifthakhar Hossan (2023), Researchgate.
3. Reza Rahmadian, Mahendra Widyartono, on Autonomous Robotic in Agriculture, IEEE Xplore (2020).
4. Chao Cheng, Jun Fu, Hang Su and Luquan Ren on Recent Advancements in Agriculture Robots: Benefits and Challenges (2023)-MDPI
5. R.Vairavan S.Sujith Sumar. Agriculture Robot for Efficient farming, June (2019), University of Zagreb.
6. Autonomous Agriculture Robot Car Controlled by an Android Smartphone Using Bluetooth by N. R. Siddique and M. H. Rahman (2017), IEEE.
7. Alexandre S.Brandao, Andre s.Sasaki, Autonomous Efficient farming robot, IEEE Journel No. 10, pp 1039-1052, (2019).