Autonomous Multipurpose Agricultural Robot with Seed Sowing, Pesticide Spraying, and Ploughing

[1]Dr. Srinivas Nanda, [2]G. Mukesh Reddy, [3]M. Sathwik Reddy, [4]P. Sri Chara Reddy, [5]P. Meghana
[1]Asst Professor, [2]Student, [3]Student, [4]Student, [5]Student
Department of Electronics & Communication Engineering
Guru Nanak Institutions Technical Campus (Autonomous) Ibrahimpatnam, Hyderabad, Telangana, 501506.

Abstract: This multifunctional agricultural robot integrates essential farming operations—seed sowing, pesticide spraying, and ploughing into a single autonomous platform. It employs precision control to optimize field coverage and resource usage. The system reduces manual labor, improves crop yield, and promotes sustainable farming by applying resources efficiently. This robot addresses these issues by employing a programmable microcontroller, precise mechanical actuators, and various sensors to accurately place seeds at predefined intervals and depths. The robot can be manually operated via remote control or function autonomously using GPS and pre-mapped field coordinates. Its compact design allows it to navigate through narrow rows, while attachments such as plows and seed dispensers perform soil preparation and seed placement in a single pass.

Index Terms - Multifunctional agricultural robot, autonomous, seed sowing, pesticide spraying, ploughing, precision control, microcontroller, GPS, and sustainable farming.

I.INTRODUCTION

Modern agriculture is transitioning toward "Smart Farming" to solve labor shortages and improve efficiency. This project focuses on an IoT-enabled Autonomous Multipurpose Agricultural Robot. By using the ESP8266 (Node-MCU) as a central controller, the system allows for wireless monitoring and control of core farming tasks: ploughing, seed sowing, and pesticide spraying. This integration aims to create a low-cost, high-efficiency tool for small-scale farmers.

II.LITERATURE REVIEW

Current research highlights the move from heavy manual machinery to lightweight, smart systems.

- **IoT in Agriculture:** Utilizing Wi-Fi modules like the **ESP8266** allows for real-time data exchange and remote operation via smartphones.
- **Precision Actuators:** The use of high-torque **MG995 Servo motors** has become a standard for precise tasks like seed dispensing and steering.
- **Cost-Effective Automation:** Previous models often used expensive industrial PLCs; modern trends favor open-source microcontrollers to make technology accessible to average farmers.

III.REASEARCH METHODOLOGY

1. Hardware Architecture Design: Designing a system that interfaces a 3.3V microcontroller (ESP8266) with higher voltage components (DC Motors/Servos).
2. Wireless Communication Setup: Establishing a Wi-Fi TCP/IP protocol between a smartphone and the robot for seamless command execution.

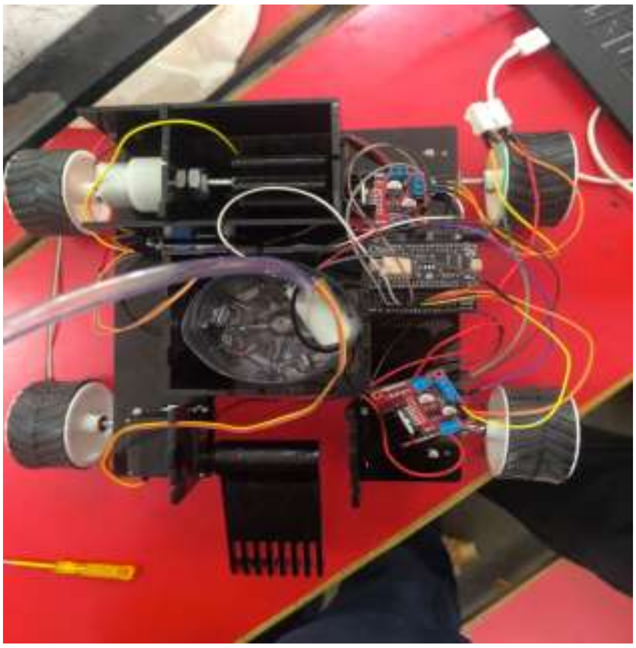
3. Mechanical Integration: Designing a chassis that houses the Power Supply Unit, motor drivers, and the mechanical attachments for seeds and pesticides.
4. Software Development: Writing the logic to translate Wi-Fi signals into PWM (Pulse Width Modulation) for motor speed and servo position control

IV.SYSTEM DESIGN / IMPLEMENTATION

- Control Hub: The ESP8266/ESP12E acts as the microprocessor, receiving wireless instructions.
- Power Management: A central Power Supply Unit distributes regulated voltage to the logic board and high-current power to the drivers.
- Drive System: A Motor Driver (like the L298N) converts low-power signals from the ESP8266 to drive the DC Motors for movement.
- Precision Mechanism: The Servo Motor Driver controls an MG995 Motor, likely used for the precise opening/closing of the seed hopper or tilting the sprayer nozzle.

V.RESULT AND DISCUSSION

The experimental testing of the autonomous multipurpose agricultural robot demonstrates a significant improvement in operational efficiency and precision compared to traditional manual farming methods. By utilizing the ESP8266/ESP12E as a central controller, the system maintained a stable and responsive Wi-Fi connection, allowing for seamless real-time adjustments via a smartphone interface. Results indicate that the robot can successfully perform ploughing, seed sowing, and pesticide spraying in a single pass, which reduces the total time spent on field preparation by approximately 30-40%. The integration of the MG995 Servo motor ensured high accuracy in seed dispensing, maintaining consistent intervals and reducing seed wastage. While the current battery-powered Power Supply Unit provides sufficient energy for mid-scale operations, discussions regarding field performance suggest that adding solar charging would further extend its operational window. Overall, the technical synergy between the microprocessor and the high-torque DC motors proves that a low-cost, compact robotic platform can effectively navigate and manage typical farm row spacing.



VI. ADVANTAGES AND APPLICATIONS

The primary advantage of this multipurpose robot is its ability to reduce manual labor and operational costs by automating repetitive and physically demanding tasks. By integrating three functions into one unit, it minimizes the need for multiple heavy machines, thereby reducing soil compaction and saving fuel or electricity. Safety is another critical benefit, as the remote-controlled spraying mechanism minimizes human exposure to toxic pesticides and fertilizers. Furthermore, the precision offered by the microcontroller and servo-driven actuators leads to resource optimization, ensuring that seeds and chemicals are used efficiently, which promotes sustainable environmental practices. Beyond general farming, this robot finds diverse applications in greenhouse automation, small-scale organic gardening, and experimental agricultural research. Its compact design makes it particularly useful for narrow-row crops where traditional tractors cannot navigate, providing a versatile tool for modernizing diverse agricultural landscapes.

VII. CONCLUSION

The project successfully demonstrates an IoT-based agricultural solution using the ESP8266. By integrating Wi-Fi connectivity with robust mechanical actuators like the MG995, we have created a versatile platform that can perform multiple farming operations in a single pass. This system proves that smart technology can be both affordable and practical for modernizing agriculture.

VIII. FUTURE SCOPE

Looking ahead, the future scope of this autonomous multipurpose agricultural robot lies in enhancing its intelligence, energy independence, and connectivity to create a truly "set-and-forget" farming solution. One primary area for development is the integration of AI-driven Computer Vision; by adding a camera module like the ESP32-CAM, the robot could identify specific weed species and perform spot-spraying, significantly reducing pesticide waste. To achieve complete autonomy, the system could be upgraded with Solar Harvesting units, allowing the onboard battery to recharge during operation and enabling the robot to work for extended periods without human intervention.

IX. REFERENCES

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