NSIEX+RS 2025
NEGERI SEMBILAN INTERNATIONAL EXPOSITION

HARMONY IN PROGRESS:

INTEGRATING SCIENCE, TECHNOLOGY, AND SOCIAL INNOVATION FOR SUSTAINABLE DEVELOPMENT GOALS

e-Book of Extended Abstract
Negeri Sembilan International (NSIEx) & Research Symposium
2025

YST032 - DEVELOPMENT OF AN AGROROVER FOR SMART AGRICULTURAL AUTOMATION TO ENHANCE PRODUCTIVITY USING WIRELESS COMMUNICATION

Muhammad Ikmal Yazid*, Nathan Randall Anak James Bae'e, and Najmiah Radiah Mohamad

Universiti Teknikal Malaysia Melaka (UTEM), Jalan Hang Tuah Jaya, 76100 Durian Tunggal, Melaka

*Corresponding author: B082210054@student.utem.edu.my

ABSTRACT

Modern agriculture is confronted by challenges including labor shortages, high technology costs, and unreliable rural power infrastructure. This thesis presents the design and development of AgroRover, an autonomous ESP32-based robotic system engineered for automated seeding operations in agricultural fields. The AgroRover integrates a linear actuator for soil penetration, a precision seed dispensing motor, and an ultrasonic sensor for real-time obstacle detection and avoidance. System monitoring and control are implemented via the Blynk IoT platform, facilitating remote operation and live data tracking through a smartphone interface. Experimental results demonstrate the system's rapid response capability, achieving an average obstacle avoidance reaction time of 782 ms and a control response time that increases linearly with distance, reaching 197 ms at 15 meters. Path-following accuracy is validated by an average drift of only 2.7 mm over a 3-meter trajectory, indicating high-precision navigation. Furthermore, battery performance analysis shows stable operation, with battery depletion curves for both operating modes confirming over 6 hours of continuous field deployment per charge. The robust wireless connectivity, reliable actuation, and scalable modular design support cost-effective implementation and future integration with renewable energy solutions. These results underscore AgroRover's potential as a practical, efficient, and scalable platform for next-generation, technology-driven precision agriculture.

Keywords – Smart AgroRover, Precision Agriculture, Autonomous Field Robot, IoT-based Agricultural Automation, Obstacle Avoidance Robotics

INTRODUCTION

The AgroRover was developed to address the growing need for efficient and affordable farming solutions, especially in rural areas where modern agricultural tools are scarce. Rising food demand, shrinking farmland, and labor shortages have made traditional methods less viable for sustaining productivity. By integrating robotics, automation, and wireless control, the AgroRover offers a cost-effective and user-friendly approach to seed planting and crop monitoring. Designed to overcome challenges such as limited access to technology, inconsistent power supply, and high equipment costs, it provides a sustainable and practical tool for improving yield and reducing manual workload in small to medium-scale farming.

OBJECTIVE

The objective of this project is to:

i. To design and develop an ESP32-based autonomous AgroRover capable of automating key agricultural tasks, including seed planting, monitoring, and maintenance.
ii. To measure the reliability of autonomous navigation by measuring the robot's ability to detect and avoid obstacles using ultrasonic sensors.
iii. To investigate the implementation of a wireless communication framework using ESP32 technology for real-time remote monitoring and control of the AgroRover's operations with a fast response time.

DESCRIPTION OF THE PROJECT

The AgroRover is an autonomous agricultural robot designed to automate seed planting and field navigation while providing real-time monitoring through IoT connectivity. Powered by an ESP32 microcontroller and integrated with the Blynk IoT platform, it allows farmers to start, stop, and adjust operations remotely using a smartphone. A linear actuator-driven dibbling mechanism creates precise planting holes, while a peripheral jaw seed dispenser ensures accurate seed placement with minimal waste. Ultrasonic sensors detect obstacles and enable automatic route adjustments, allowing uninterrupted operation in dynamic field conditions. Built on a lightweight aluminum chassis with rubber-treaded wheels, the AgroRover is durable, mobile, and able to operate for over six hours on a single charge. Its modular design allows easy maintenance and future upgrades, making it a practical, cost-effective, and sustainable solution for small to medium-sized farms.

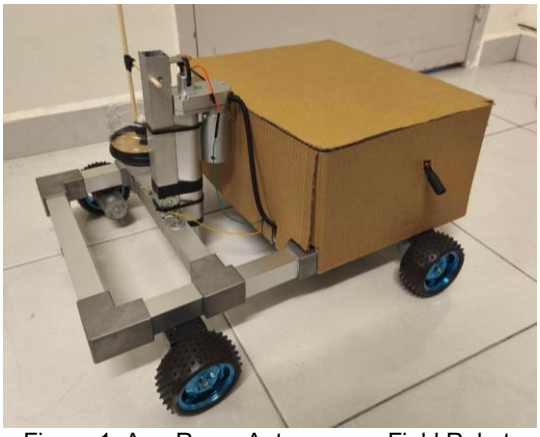

Figure 1: AgroRover Autonomous Field Robot.

Table 1: Key Features and Specifications of the AgroRover

Component	Description	Function	Specification	Benefit
Microcontroller	ESP32	Central control and IoT connectivity	Dual-core, Wi-Fi & Bluetooth	Low-cost, wireless monitoring & control
Planting Mechanism	Linear actuator with peripheral jaw dispenser	Creates holes and places seeds	Hole depth: 3–5 cm	Accurate, consistent planting
Navigation Sensor	Ultrasonic sensor	Detects obstacles & adjusts path	Range: ~20 cm detection	Prevents collisions

NOVELTY

The AgroRover is unique in combining low-cost automation, IoT connectivity, and precision planting into a single, accessible platform for small and medium-scale farming. Using an ESP32 microcontroller with the Blynk IoT platform, it enables real-time monitoring and control from anywhere via smartphone, overcoming the range limits of traditional systems. Its planting mechanism pairs a linear actuator-based dibbling system with a peripheral jaw seed dispenser for accurate hole depth and seed placement, while ultrasonic sensors provide real-time obstacle detection and automatic path adjustments. The modular design allows quick component replacement or upgrades, reducing downtime and costs. With over six hours of operation per charge, it is practical for areas with limited power supply. This blend of affordability, precision, and adaptability makes the AgroRover a novel solution for introducing precision agriculture to communities with limited access to advanced farming technology.

CONCLUSION

The AgroRover project demonstrates how affordable automation and IoT integration can effectively enhance agricultural productivity for small and medium-scale farms, particularly in rural areas with limited access to modern tools. Built on an ESP32 microcontroller and connected to the Blynk IoT platform, the system enables real-time monitoring and remote control through a smartphone, offering user-friendly operation regardless of location. Field testing confirmed its capability to navigate autonomously, detect and avoid obstacles, and maintain precise planting through a linear actuator-based dibbling mechanism paired with a precision seed dispenser. Its modular design simplifies maintenance and allows future upgrades, while its six-hour operating time per charge makes it practical for small to medium-sized plots. By automating repetitive planting tasks, the AgroRover addresses labor shortages, optimizes seed usage, and enables timely farming decisions through live data feedback. More than just a prototype, it provides a sustainable, cost-effective solution that can be adapted to various crops and farming conditions, offering an accessible entry point into precision agriculture. With further enhancements such as renewable energy integration and expanded automation features, the AgroRover holds strong potential to drive the adoption of smart farming technologies, reduce reliance on manual labor, and improve yields in diverse agricultural environments.

REFERENCES

Kumar, A., & Rajagopal, H. (2021). Automated Seeding and Irrigation System Using Arduino. Journal of Robotics, Networking and Artificial Life, 6(3), 143-147. https://doi.org/10.2991/jrnal.k.200512.002

Rahman, M. M., & Islam, M. S. (2023). Enhancing Agricultural Productivity Through a Semi-Autonomous IoT Robot in Smart Farming Systems. Bangladesh Journal of Agriculture, 48(2), 94-105. https://doi.org/10.3329/bjagri.v48i2.70162

Danve, S. R., & Patil, S. S. (2020). Design and Development of an Agri-bot for Automatic Seeding and Watering Applications. *Proceedings of the Second International Conference on Innovative Mechanisms for Industry Applications (ICIMIA)*. IEEE. https://doi.org/10.1109/ICIMIA48430.2020.9074856

T. Nagdeve, P. Jangde, H. Tandulkar, S. Dhara, N. Ukani and S. Chakole, "Design of Automated Seed Sowing Robot for BT Cotton Seed," 2020 Second International Conference on Inventive Research in Computing Applications (ICIRCA), Coimbatore, India, 2020, pp. 303-307, doi: 10.1109/ICIRCA48905.2020.9183259