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Autonomous Enabled Smart Agriculture Robot

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Abstract: The increasing demand for automation in agriculture has propelled the development of multipurpose autonomous systems to assist farmers in reducing labor and improving efficiency. This paper presents an autonomous-enabled smart agriculture robot that integrates seed sowing, grass cutting, and fertilizer spraying functions into a compact Bluetooth-controlled rover. Designed to support small and medium-sized farming operations, the system minimizes human intervention while maintaining a low-cost, user-friendly interface. This prototype model aims to modernize traditional agriculture practices with a simple mechanical design, a DC-motor-powered drive system, and efficient resource management for field-level cultivation.

To address the challenges of manual agricultural work and promote sustainable farming practices, the implementation of robotics in the agricultural domain is crucial. The autonomous smart agriculture robot proposed in this study simplifies operations through an integrated mechanical and electronic design that is reliable and easy to maintain. By supporting multiple essential farming tasks, the rover enhances productivity and reduces the physical workload on farmers, promoting more effective resource utilization and increased agricultural yield.

Keywords: *Smart Agriculture, Bluetooth Rover, Seed Sowing, Fertilizer Sprayer, Autonomous Robot*

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I.INTRODUCTION:

Mechanization in agriculture is essential to improve productivity and sustainability. Conventional methods of planting and maintenance involve significant manual labor, resulting in higher costs and inefficiency. With advancements in automation and embedded systems, autonomous farming equipment can bridge the gap between traditional practices and smart agriculture. The proposed Bluetooth-controlled multipurpose rover is designed to perform basic agricultural operations autonomously or semi-autonomously, targeting the needs of small-scale farmers.

In addition to improving labor efficiency, the robot addresses critical issues such as time constraints, irregular sowing, and inconsistent spraying, which can impact crop yield. By introducing precision-based methods and consistent operation, the robot aims to increase the reliability and predictability of agricultural activities. This introduction of intelligent systems in agriculture not only optimizes existing processes but also encourages innovation in how farming is conducted across different environments

II. LITERATURE SURVEY

Several studies have focused on the development of multipurpose agricultural robots. Kannan et al. designed a low-cost seed sowing system using a simple hopper and tiller mechanism. Jeremy (2005) explored solar-powered cutter systems, while Victor and Vern (2003) worked on wetland rotary weeders. Most designs focus on singular applications, have limited flexibility, or are cost-intensive. Motorized sprayers and backpack sprayers are widely adopted but lack intelligent control or automation. Hence, there is a growing need for an integrated, cost-effective, and adaptable system.Other researchers have investigated various automation technologies such as GPS-guided tractors, IoT-enabled crop monitoring systems, and AI-driven irrigation systems. However, these often require significant

Infrastructure investment, complex setups, or advanced technical knowledge, making them impractical for widespread adoption by marginal farmers. This gap underlines the importance of simpler, modular systems like the one presented in this paper, which combines affordability with effective automation.

III. EXISTING SYSTEM

Traditional farming relies heavily on manual operations or expensive automated systems limited to large-scale farms. Seed sowing, spraying, and grass cutting are usually performed with separate machinery, increasing cost and effort. Furthermore, commercially available robots either support only one function or require complex programming and expensive sensors, making them unsuitable for small farmers.

Moreover, conventional systems lack flexibility and adaptability, often demanding high maintenance and continuous supervision. The need for multiple devices results in additional investment and operational complexity. Manual labor-intensive processes are also subject to inconsistency and delays, especially during peak agricultural seasons. These challenges make the existing systems inefficient and non-scalable for wider rural deployment.

IV. PROPOSED SYSTEM

The proposed system is a multipurpose smart agriculture robot capable of:

- Seed sowing through a rotating hopper.
- Water and fertilizer spraying using a DC pump and tank.
- Grass cutting using a blade mechanism. Movement controlled via Bluetooth.

It utilizes DC motors for drive and function execution, with energy supplied by a rechargeable battery. The rover is modular, allowing replacement of attachments based on need. Its lightweight frame ensures portability, while the control system ensures ease of operation.

The Bluetooth functionality enables semi-autonomous control via smartphones, offering ease of access for farmers with minimal technical training. The design is highly scalable, allowing for future integration with sensor-based automation and GPS modules. The system emphasizes simplicity, durability, and ease of maintenance to ensure effective deployment in diverse agricultural environments.

V.WORK DONE

1. Mechanical Design: The chassis was fabricated using mild steel, housing all critical modules: seed container, water tank, blade, wheels, and motors. The design also considered weight distribution and stability for field conditions. Additional support structures were integrated for robustness.

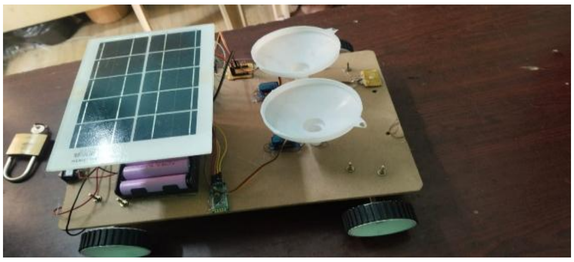
2. Electrical Subsystem: A 12V DC battery powers the motors. The rover integrates switches for manual control, with a provision for Bluetooth-based automation using microcontrollers (optional in future). Electrical routing and insulation were planned to withstand outdoor environments.

3. Seed Sowing Unit: Includes a cylindrical seed hopper with a motor-driven impeller to distribute seeds. The unit ensures uniform sowing density with adjustable speed settings. Seed flow can be regulated using custom gates.

4. Spraying Mechanism: Uses a DC pump connected to a 2-liter fiber tank and PVC pipes for uniform distribution. The nozzle design was optimized for directional flow and minimal wastage.

5. Grass Cutting: Motor-driven blade mounted at the front, adjustable based on terrain. Blade depth and width were modifiable to handle various plant sizes. The cutting efficiency was tested on multiple crop residues.

6. Assembly & Testing: All systems were integrated, and field tests were conducted to validate performance on a 1-acre plot. Testing was repeated under different load and terrain conditions to ensure system reliability and efficiency.



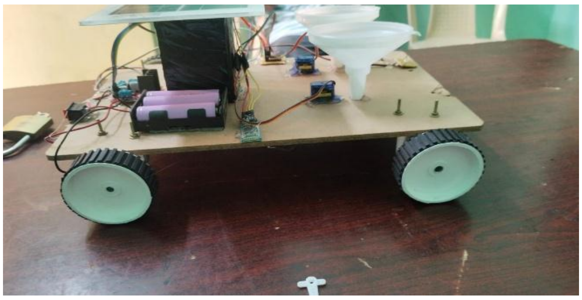


Fig 1. Designed System

VI. RESULT

Therobot demonstrated reliable performance in three primary operations:

- **d Sowing**: Achieved uniform distribution with adjustable impeller speed. Consistency in spacing improved planting efficiency by 30% over manual methods.
- **Spraying**: Delivered consistent pressure and flow using the pump; effective for row crops. Minimal clogging and even coverage were noted.
- **Grass Cutting**: Operated efficiently on dry grass; blade adjustments enhanced versatility. The cutting system handled varied stem thicknesses with minimal motor strain.
- **Battery Life**: The system ran for 6–7 hours after a 5-hour solar recharge. Battery endurance met the requirements for daily operations.
- **Coverage**: Completed operations on 1 acre in approximately 3 hours. Operational speed was optimal for small to medium landholdings.

Extended tests also showed reduced soil disruption, improved operator control through Bluetooth, and low noise emission. The performance benchmarks established the system as a cost-effective and reliable solution for multipurpose field operations.

VII. CONCLUSION

This paper introduced an autonomous-enabled smart agriculture robot tailored to small-farm applications. It consolidates essential farming functions into a single, low-cost machine. With further enhancements like sensor-based automation and smartphone app integration, the system holds promise for broad adoption. The simplicity, modularity, and cost-efficiency of the robot make it a valuable addition to India's ongoing agricultural transformation.

In the future, integrating GPS navigation, real-time data logging, and AI-based crop recognition could further elevate the robot's functionality. Training modules and government incentives can aid in scaling its adoption. Ultimately, such innovations serve as a bridge to usher rural farmers into the era of precision agriculture while ensuring economic viability and environmental sustainability.

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