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Solar Power Multi-Purpose Agri Bot: Design and Development of a 6-Wheel Rocker Bogie Based Agricultural Robot

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Abstract: This paper presents the design and development of a Solar Power Multi Purpose Agri Bot designed to assist small-scale farmers in performing essential agricultural tasks efficiently. The robot incorporates a 6-wheel rocker bogie mechanism for stable movement on uneven agricultural terrain. The system integrates seed sowing, water spraying, soil drilling, and high-speed grass cutting functionalities in a single robotic platform. Powered by a 12V high-capacity rechargeable battery and supported by solar charging, the robot operates using an Arduino Uno microcontroller, L298N motor driver, and Bluetooth control system. The proposed system reduces manual labor, increases efficiency, and promotes sustainable farming through renewable energy utilization.

1. INTRODUCTION

Agriculture remains one of the most essential sectors supporting global food production and economic stability. However, traditional farming practices rely heavily on manual labor, resulting in increased operational costs, reduced efficiency, and physical strain on farmers. Additionally, agricultural lands often contain uneven terrain, mud surfaces, and small obstacles, making it difficult for conventional machines to operate effectively.

Recent advancements in robotics, embedded systems, and renewable energy technologies have opened new possibilities for smart farming solutions. Agricultural robots are capable of performing repetitive and labor-intensive tasks such as seed sowing, irrigation, soil preparation, and weed removal with improved precision and efficiency. Integrating renewable energy sources such as solar power further enhances sustainability and reduces dependence on external power supplies.

This paper presents the design and development of a **Solar Power Multi-Purpose Agri Bot**, a 6-wheel rocker bogie based agricultural robot capable of performing multiple farming operations including seed sowing, water spraying, and grass cutting. The rocker bogie mechanism enables stable movement across uneven agricultural terrain. The system is powered by a 12V rechargeable battery supported by solar charging and controlled using an Arduino Uno microcontroller with Bluetooth-based wireless operation.

The objective of the proposed system is to reduce manual labor, improve farming efficiency, and provide a cost-effective, energy-efficient automation solution for small and medium-scale farmers.

2. Methodology

The Solar Power Multi-Purpose Agri Bot is designed using a modular approach integrating mechanical, electrical, and control systems. The robot is built on a 6-wheel rocker bogie mechanism to ensure stable movement on uneven agricultural terrain. DC gear motors are used for locomotion and are controlled through an L298N motor driver module.
The system is powered by a 12V rechargeable battery, which is supported by a solar panel for continuous charging during operation. An Arduino Uno microcontroller acts as the central control unit, coordinating all subsystems through programmed instructions. Bluetooth connectivity enables wireless control of the robot using a mobile device.
The seed sowing mechanism operates using a servo motor that regulates seed release at fixed intervals. A DC water pump connected to a water tank performs irrigation through spraying nozzles. Grass cutting is achieved using a high-speed 775 DC high-torque motor attached to a rotating blade system.
All components work in coordination to perform multiple agricultural operations efficiently within a single robotic platform.

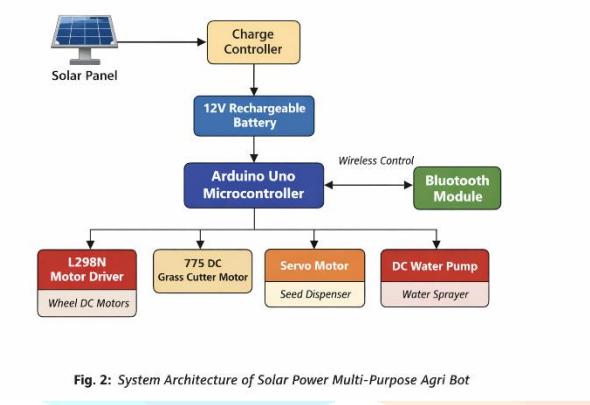

Fig. 2: *System Architecture of Solar Power Multi-Purpose Agri Bot*

- Arduino Uno
- Bluetooth module (Control)
- L298N motor driver (Control motor powers)
- 775 Dc motor (Grass cut)
- Servo Motor (for seed gate control)
- Water pump module (Water spray)
- Jumper Wires (Connections)
- Power Supply (9V/12V Battery or Adapter)

3. Working Principle

The proposed Agriculture Robot is designed to automate essential farming operations such as seed sowing, water spraying, or grass cutting with minimal human intervention. The system is powered by a 12V battery and controlled by a microcontroller-based control unit
When the system is switched ON, the controller initializes all connected components, including drive motors, operational motors (seed dispenser / water pump / cutting motor), and sensors. The DC gear motors enable the robot to move forward across the agricultural field in a controlled manner.

Based on the configured application:
In seed sowing mode, a motor-driven dispensing mechanism releases seeds at predefined intervals to ensure uniform spacing.
In spraying mode, a water pump distributes water or liquid fertilizer evenly over the crops.

In grass cutting mode, a high-speed motor rotates a cutting blade to trim unwanted vegetation efficiently.
If an obstacle detection sensor (such as an ultrasonic sensor) is integrated, the robot continuously monitors its path. Upon detecting an obstacle, the controller immediately stops the movement, alters direction, and resumes operation to ensure uninterrupted workflow.

This automated mechanism enhances agricultural productivity, reduces manual labor, ensures precision in field operations, and promotes efficient resource utilization.

Step 1: Start the system.
Step 2: Power ON all sensors and electronic components.
Step 3: Establish Bluetooth connection with the controlling device (mobile/controller).
Step 4: Send movement command through the connected device.
Step 5: Robot moves forward in the field.
Step 6: Perform farming operations such as:

- Seed sowing
- Water spraying
- Grass cutting

Step 7: Continue operation until the entire land area is covered.
Step 8: Stop the robot after completing the full land coverage.

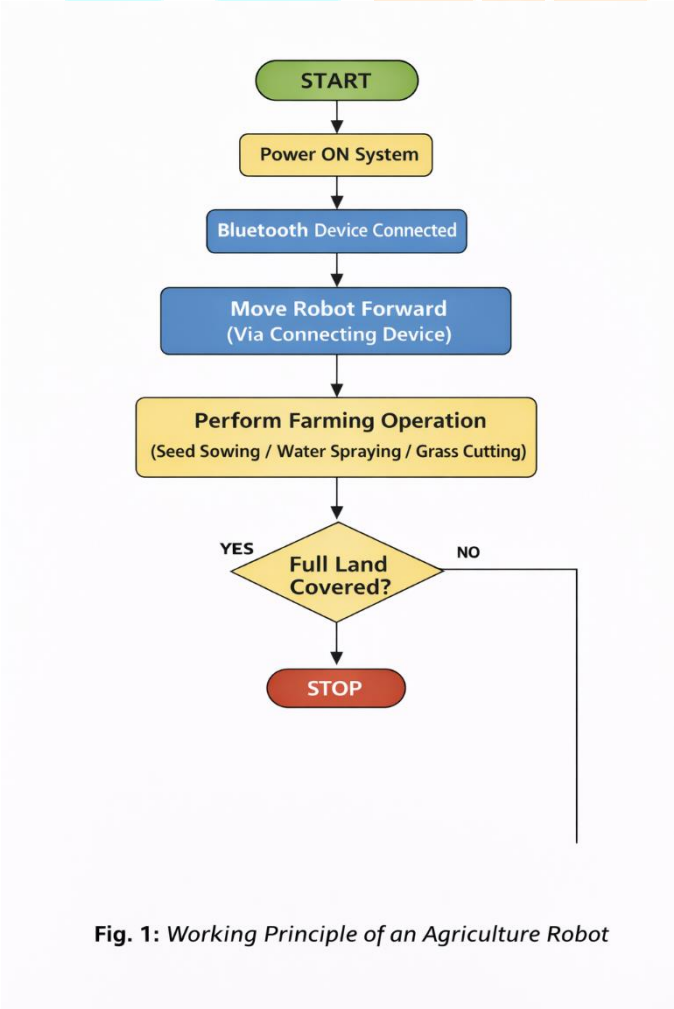

Fig. 1: *Working Principle of an Agriculture Robot*

➢ **Flowchart Description (Stepwise Explanation)**

4. Experimental Results

The developed Agriculture Robot was experimentally tested in a controlled agricultural field environment to evaluate its performance in seed sowing, water spraying, and grass cutting operations. The system was powered using a 12V battery and controlled via a Bluetooth-enabled mobile device. During the testing phase, the robot successfully established a stable Bluetooth connection and responded accurately to movement commands. The drive motors enabled smooth forward motion across the field surface. The seed dispensing mechanism released seeds at regular intervals, ensuring uniform spacing. The water spraying system distributed water evenly over the designated area, and the grass cutting mechanism operated effectively in trimming unwanted vegetation.

5. Advantages

- Reduces manual labour in agricultural operations
- Saves time and increases field productivity
- Ensures uniform seed sowing and water distribution
- Minimizes water and resource wastage
- Easy to control using Bluetooth device
- Cost-effective solution for small-scale farmers
- Improves operational efficiency and accuracy

6. Applications

- Seed sowing in agricultural fields
- Water spraying and irrigation support
- Grass cutting and weed removal
- Small-scale and precision farming
- Research and educational agricultural projects

7. Future Scope

- Integration of IoT for remote monitoring and control
- Addition of soil moisture and temperature sensors
- Implementation of GPS for automated navigation
- Solar panel integration for sustainable power supply
- AI-based crop monitoring and decision-making system

8. Conclusion:

The proposed Agriculture Robot has been successfully designed, developed, and experimentally validated to perform key farming operations such as seed sowing, water spraying, and grass cutting in a controlled agricultural environment. The system demonstrated stable Bluetooth connectivity, smooth mobility, and reliable execution of assigned tasks with satisfactory accuracy and efficiency.

The integration of motor-driven mechanisms with a microcontroller-based control unit enables precise field operations while maintaining low power consumption. Experimental observations confirm that the robot can uniformly distribute seeds and water while effectively trimming unwanted vegetation, thereby ensuring consistent agricultural output.
This system significantly reduces human effort, operational time, and resource wastage, making it a practical and economical solution for small- and medium-scale farmers. Furthermore, the modular design allows future enhancements such as IoT integration, autonomous navigation, and sensor-based smart monitoring.

Overall, the developed Agriculture Robot represents a step toward sustainable and intelligent farming by combining automation, precision, and affordability in a single compact system.

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