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Solar Powered Seed Sowing Machine

Shambulingana Goud[1], V Mythriye[2], Sushmitha H[3], Shivashankar RK[4], Gangadhar C[5]
Associate Professor, Electrical and Electronics Engineering[1]
Student, Electrical and Electronics Engineering[2-5]
Rao Bahadur Y. Mahabaleswarappa Engineering College, Ballari, India

Abstract: *The solar-powered seed sowing machine is an innovative agricultural device developed to automate and optimize the seed sowing process using renewable energy. The system integrates a photovoltaic panel that powers a motor-driven seed metering and furrow-opening mechanism, ensuring accurate seed depth and spacing. By harnessing solar power, the machine eliminates the need for fuel-based engines and reduces operational costs. Its design focuses on portability, user convenience, and reliability, making it suitable for small and medium-scale farming. The machine reduces manual labour, enhances sowing precision, and improves overall crop quality by ensuring uniform seed distribution. Additionally, the solar-powered operation promotes environmental sustainability and supports the transition toward clean energy in agriculture. The project aims to provide a low-cost, efficient, and eco-friendly alternative to traditional seed sowing methods.*

Keywords: Ultracapacitor-Integrated Solar Seed Sowing System, Moisture-Based Automated Sowing Technology, Water-Assisted Precision Agriculture Mechanism, Renewable Energy–Driven Smart Farming Equipment

I. INTRODUCTION

Agriculture is a key sector in developing countries, and improving the efficiency of sowing operations is essential for enhancing crop productivity. Traditional seed sowing methods are labor-intensive and often result in uneven spacing, leading to poor germination. To address these challenges, this project presents a solar-powered automated seed sowing machine that provides a sustainable, low-cost, and efficient solution for farmers. The system incorporates a solar panel with a rechargeable battery and an ultracapacitor-based water-assisted power unit to ensure stable operation under varying sunlight conditions. An Arduino Uno microcontroller controls wheel movement, seed metering, spacing, and sowing depth through an L293D motor driver and relay circuit, while the hopper, metering disc, and funnel ensure precise seed placement. A soil moisture sensor further enhances accuracy by enabling sowing based on real-time field conditions. This design reduces labor, minimizes seed wastage, and promotes precision agriculture, making it especially suitable for rural areas with unreliable electricity. With potential upgrades such as GPS navigation, IoT connectivity, and advanced soil sensing, the system provides a robust foundation for future smart and sustainable farming technologies aligned with national initiatives like “Make in India” and “Atmanirbhar Bharat.”

II. PROBLEM STATEMENT

Manual seed sowing is slow, labour-intensive, and often leads to inconsistent seed depth and spacing, reducing overall crop yield. Existing diesel-based sowing machines, though faster, are costly to operate, require continuous fuel supply, and cause environmental pollution, making them unsuitable for small farmers. In many rural areas, limited access to fuel and electricity further restricts the use of conventional machinery. Therefore, there is a need for a low-cost, sustainable, and reliable solution that reduces manual effort, ensures uniform seed placement, and operates independently of external power sources. This project addresses the gap by proposing a solar-powered seed sowing system that enhances precision and productivity while promoting eco-friendly farming.

III. LITERATURE REVIEW

Previous research on automated seed sowing systems has mainly focused on solar-powered mechanisms, simple battery storage, and basic seed-metering designs to reduce labour and improve sowing accuracy. Some studies have explored microcontroller-based control using Arduino and L293D motor drivers for coordinating movement and seed dispensing, while others have introduced soil-moisture sensors to support precision farming. Ultracapacitors have also been studied for their ability to deliver quick energy bursts and stabilize power supply in solar-based agricultural tools. However, existing systems generally lack an integrated approach that combines solar energy harvesting, ultracapacitor-assisted stable power delivery, moisture-based decision making, and synchronized seed placement in a single, compact machine suitable for rural conditions.

Our Contributions:

1.We developed a solar-powered seed sowing system enhanced with an ultracapacitor-based stable power unit.

2.We integrated soil-moisture sensing to enable intelligent, condition-based seed sowing.

3.We designed a compact Arduino-controlled mechanism for accurate seed spacing and depth at low cost.

IV. RESEARCH METHODOLOGY

The proposed system uses an Arduino UNO as the central controller to integrate solar power, ultracapacitor-based energy support, sensor automation, and motorized seed-sowing mechanisms. Solar energy is stored in a rechargeable battery and stabilized through an ultracapacitor–water unit to ensure reliable power delivery. The soil-moisture sensor provides real-time data for moisture-based sowing decisions, while the ultrasonic sensor ensures obstacle-free movement. The Arduino processes these inputs and controls BO motors through the L293D driver for mobility and seed placement, and operates the relay for power switching. Bluetooth connectivity allows wireless user commands from a smartphone, enabling manual override when needed. This methodology combines renewable energy, sensing, wireless control, and automated actuation into a compact, low-cost, and precise seed-sowing platform suited for modern agriculture.

V. WORKING

The Arduino UNO controls the entire system by receiving soil-moisture readings to decide when to activate the water pump through a relay and using the ultrasonic sensor to detect obstacles while the L298D motor driver operates the four DC motors for movement. The servo driver controls the servo motors for precise mechanical actions such as seed dispensing, ensuring accurate operation. A Bluetooth module enables wireless control from a smartphone app, allowing the user to start, stop, and navigate the machine remotely. All components work together to create a compact automated unit capable of moving across the field, sensing soil conditions, irrigating when required, and performing sowing-related tasks efficiently.

WORKING PRINCIPLE

Step 1: Sensors collect data – humidity for soil moisture, ultrasonic for obstacles.
Step 2: Arduino processes sensor data and decides actions.
Step 3: Relay powers water pump if soil is dry.
Step 4: Stepper and servo motors perform movement and seed sowing.
Step 5: Bluetooth allows smartphone monitoring and control.
Step 6: System runs automatically with optional manual override.

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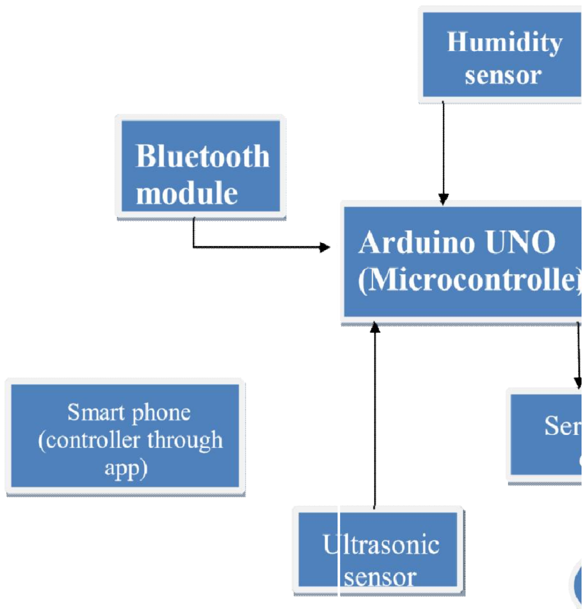
VI. BLOCK DIAGRAM



COMPENTS USED

- Arduiniuno
- Powersupply
- Relaydriver
- Battery
- BatteryOperatedmotor
- LEDlight
- Solarpanel
- LM293Dmotordriver
- Powerbooster

VII. COMPONENTS DESCRIPTION

Arduinouno(Microcontroller):

The Arduino UNO is the central processing unit of the system. It is a microcontroller board based on the ATmega328P chip that reads inputs from various sensors, processes the data, and sends control signals to actuators like motors and relays. In this system, it coordinates the operation of sensors, motor drivers, and the Bluetooth module to automate tasks such as movement, water pumping, and object detection. It acts as the brain of the setup, enabling communication between sensors, motors, and user interfaces.

Humiditysensor:

The humidity sensor detects the moisture level in the soil or surrounding environment. It converts the moisture content into an electrical signal that the Arduino can interpret. This data is essential for controlling irrigation automatically; when the humidity drops below a set threshold, the Arduino triggers the water pump through the relay driver to maintain optimal soil conditions for plant growth.

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RelayDriver(WaterPump):
The relay driver acts as an electronic switch that allows the Arduino to control high-power devices like a water pump. Since the Arduino operates at low voltages, it cannot drive motors or pumps directly. The relay driver receives a signal from the Arduino and closes the circuit to power the water pump, enabling automatic irrigation based on soil moisture levels.

298D/MotorDriver(M1,M2,M3,M4):
The 298D motor driver is used to control DC motors in the system. It receives signals from the Arduino to drive multiple motors (M1 to M4) in forward or reverse directions. These motors could be part of a robotic mechanism, such as a seed sowing machine or automated cart, providing precise motion control for movement and operational tasks.

ServoMotorDriver(ServoMotor1andServoMotor2):
The servo motor driver is responsible for controlling servo motors, which require precise angular position control. The Arduino sends PWM (Pulse Width Modulation) signals to the servo driver, which then adjusts the position of the connected servo motors. These motors could be used for controlling mechanisms like seed dispensers, robotic arms, or directional adjustments in the system.

UltrasonicSensor:
The ultrasonic sensor measures distance by emitting high-frequency sound waves and calculating the time it takes for the echo to return. The Arduino uses this information to detect obstacles or measure object positions, ensuring the machine can navigate or operate without collisions. It is crucial for automation and safety in mobile or robotic systems.

BluetoothModule:
The Bluetooth module allows wireless communication between the Arduino and a smartphone or other Bluetooth-enabled device. It receives commands from a controlling app, enabling the user to operate the system remotely. This feature adds flexibility, allowing manual override or adjustments to automated processes.

Smartphone(ControllerthroughApp):
The smartphone acts as the user interface for the system. Through a dedicated application, the user can send commands via Bluetooth to the Arduino. This allows monitoring, manual control, and customization of system parameters such as motor speed, servo angles, or irrigation schedules, making the system interactive and user-friendly.

VIII. ADVANTAGES

- **Eco-Friendly Solution:** The project promotes sustainable agriculture by using renewable solar energy, reducing carbon footprint and environmental impact.
- **Cost-Effective Operation:** Eliminates fuel costs and reduces maintenance, making it economically beneficial for farmers.
- **Labor and Time Saving:** Automates the sowing process, reducing manual effort and enabling faster coverage of large fields.
- **Precision and Efficiency:** Ensures uniform seed placement and depth, improving germination rates and crop yield.
- **Technologically Advanced:** Integrates modern agricultural techniques with solar-powered automation, encouraging innovation.
- **Accessibility in Remote Areas:** Can function without electricity, supporting farmers in off-grid and rural regions.
- **Improves Farming Productivity:** Helps farmers achieve better results with less effort, contributing to overall agricultural efficiency.

IX. LIMITATIONS

- **Higher Initial Cost:** More expensive upfront compared to traditional manual sowing methods.
- **Terrain Limitations:** May face difficulty operating on extremely uneven, rocky, or muddy fields.
- **Maintenance Requirement:** Repairs and maintenance require basic knowledge of electronics and mechanical components.
- **Seed Type Limitation:** May not be suitable for all types of seeds or very small/very large seeds without adjustment.

X. CONCLUSION

The development of the Solar Powered Seed Sowing Machine demonstrates how renewable energy and simple automation can be combined to create an efficient, cost-effective agricultural tool. By relying on solar power, the system performs essential farming operations such as movement, seed dispensing, soil sensing, and depth control without the need for conventional electricity or fuel, making it particularly beneficial for rural and remote areas. During testing, the machine achieved uniform seed spacing, reduced manual effort, and improved operational accuracy, while its ability to sense soil conditions like temperature and moisture supports more informed sowing decisions. The project not only fulfills its functional objectives but also promotes sustainable farming practices through labor reduction, precision, and clean energy use. Furthermore, by integrating smart technologies, the prototype lays a foundation for future enhancements such as IoT connectivity, GPS navigation, and multi-function capabilities, paving the way for versatile, technology-driven solutions that can boost productivity and eco-friendly agriculture on various scales.

XI. FUTURE SCOPE

Future improvements for the Solar Powered Seed Sowing Machine include IoT-based remote monitoring, a mobile app for control, and GPS-guided autonomous navigation. Features like multiple seed hoppers, adjustable spacing and depth, and advanced soil sensors can enhance precision and versatility. Power efficiency can be improved with larger solar panels or hybrid energy options, while a stronger chassis, better wheels, and high-torque motors can boost performance on rough terrains. Additional modules for fertilizer dispensing, weeding, or spraying can make the machine a multipurpose agricultural robot, increasing both productivity and efficiency.

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About Authors

	Name–Dr.Shambulingana Goud Designation-Associate professor B.E(Electrical and Electronics Engineering) Rao Bahadur Y Mahabaleshwarappa Engineering College Email ID- shambu1401@gmail.com PHDINRESEARCHIN3-PHASEINDUCTION MOTOR

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	Name – V Mythriye Designation-Student USN– 3VC22EE067 PhoneNumber–9353830478 E-mail id - mythri.eee.rymec@gmail.com
	Name–SushmithaH Designation-Student USN –3VC22EE061 PhoneNumber–9019984410 E-mail id –sushmitha.eee.rymec@gmail.com
	Name–GangadharaC Designation- Student USN – 3VC22EE022 PhoneNumber–9743588329 E-mail id – gangadharac022.eeerymec@gmail.com
	Name–ShivashankarRK Designation- Student USN – 3VC22EE057 PhoneNumber– 7795383787 E-mail id- rudrashiva452@gmail.com

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