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Development and Manufacture of Solar Power Seed Sprayer Machine

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Abstract: ***In India, where 70% of the population relies on agriculture, it's crucial to modernize farming practices to alleviate the manual burden on farmers. Presently, tasks like seed sowing are labor-intensive and time-consuming. To address this, we propose the development of a universal automated seed sowing machine. This innovation aims to streamline seed sowing by precisely dropping seeds at predetermined intervals and lines, effectively reducing manual labor. The machine utilizes a control mechanism to ensure accurate seed placement and automatically closes the furrows after sowing. By implementing such technology, we can significantly decrease farmers' efforts, save time, energy, and labor costs in agricultural operations. This project focuses on the development of a Solar Seed Sprayer Machine to address the growing need for efficient agricultural techniques. The machine utilizes solar power to spray seeds onto fields, eliminating the need for manual seeding. By streamlining the process, it reduces time, labor, and energy consumption while enhancing crop production. The system consists of a seed hopper and mechanisms for seed distribution, ensuring optimal seed-to-soil contact for germination. Incorporating modern technologies, such as Bluetooth modules and DC motors, enhances its functionality and efficiency. Overall, this innovative solution offers a sustainable approach to seed sowing, promoting soil preservation and crop growth.***
Keywords: Seed Sprayer Machine, Relay,Bluetooth Module, Robot, Battery, Solar Panel, DC Motors.

I. INTRODUCTION

From the Green Revolution to policy reforms and technological advancements, Indian agriculture has undergone significant transformations over the decades, adapting to evolving challenges and opportunities. Despite progress, issues like land fragmentation, water scarcity, and market inefficiencies persist, further compounded by the COVID-19 pandemic. With 70% of the population engaged in farming, ensuring sustainable agricultural development is paramount for food security, rural livelihoods, and environmental preservation.

II. LITERATURE REVIEW

1) Suganya and Jayaranjani introduced a seed sprayer machine incorporating solar power and Bluetooth connectivity, offering potential advancements. However, the system's complexity may hinder its practicality in today's context.
2) Ravi, GobiGanesh, Gokulakannan, Kandeeswaran, and Kesavan presented a seed sprayer machine driven solely by fuel, indicating a notable disadvantage due to environmental concerns and operational costs.
3) Pawar, Gorane, Labhade, and Jadhav proposed a seed sprayer machine controlled by mobile devices, suitable for harsh environments but potentially limited by its complexity and higher cost.
4) Al-Talib, Xian, Atiqa, and Abdullah introduced a solar-powered seed sprayer machine, offering basic functionality but lacking adaptability to different environments and technological advancements.
5) Overall, while each study contributes valuable insights, there remains a need for a comprehensive solution that balances efficiency, environmental sustainability, and cost-effectiveness in modern agricultural practices.

III. PROBLEM IDENTIFICATION

Based on the findings of the literature review, it was observed that existing studies lacked mechanisms for sowing multiple seeds in evenly spaced rows and for covering the seeds with soil after sowing. Therefore, this project aims to address these gaps by developing an automated multiple seed sowing process and incorporating a soil-closing mechanism. The proposed solution, termed the Universal Seed Sowing Machine, is designed to significantly reduce labor costs and time associated with traditional methods.
With the global population expected to increase rapidly, there is a pressing need for innovative technologies to enhance agricultural productivity. Achieving uniform seed spacing is crucial for optimal plant growth and yield.

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Additionally, heavy machinery poses challenges in muddy fields, potentially damaging the soil. Hence, the Universal Seed Sowing Machine is designed to be lightweight and cost-effective, ensuring efficient seed sowing while minimizing soil disturbance.

IV. PROPOSED SYSTEM

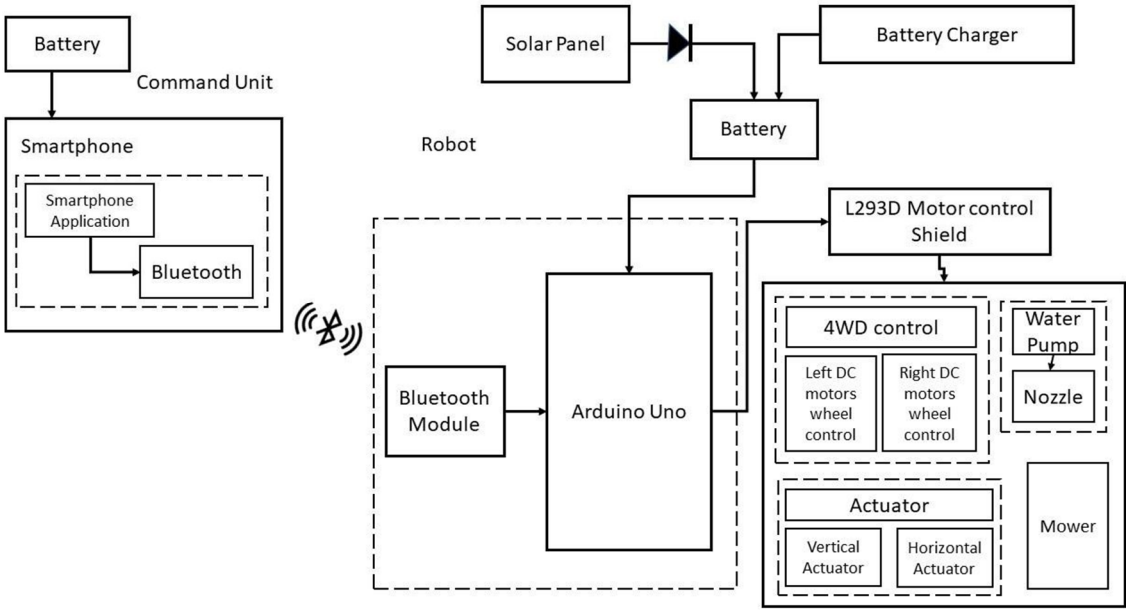


Fig 1 Block diagram of proposed system

The Agro Robot, designed for agricultural and sports field maintenance, incorporates Arduino technology, an L293D Motor Control Shield, HC-05 Bluetooth Module, 4-wheel drive with 4 DC Motors, a water pump, nozzles, mower setup, battery, and solar panel. This innovative machine, equipped with manual sun-tracking solar panels, efficiently performs multiple tasks concurrently. Addressing concerns over labor shortages in farming, it enhances productivity by eliminating the need for manual labor. The integration of various electrical components is managed through a combination of Arduino board and Motor Shield.

V. EXPERIMENTAL SETUP

1) Solar Panel (10W):



Fig 2 Solar Panel

A solar panel is a device that converts sunlight into electricity through the photovoltaic effect. The 10W rating indicates its power output capacity.

2) Brush-less DC Motor (High Speed 2000 RPM):



Fig 3 Brushless DC Motor

A brush-less DC motor operates using electronic commutation instead of brushes, providing higher efficiency and reliability. The 2000 RPM rating specifies its rotational speed.

3) Arduino Uno (328p):



Fig 4 Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328P chip. It provides an open-source platform for prototyping and developing various electronic projects.

4) LCD Display (16x2):

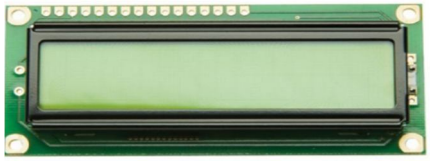


Fig 5 LCD Display (16x2)

An LCD (Liquid Crystal Display) screen capable of displaying 16 characters per line and 2 lines. It is commonly used for providing visual feedback in electronic projects.

5) Bluetooth Module:

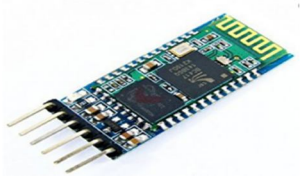


Fig 6 Bluetooth Module

A Bluetooth module enables wireless communication between devices. It allows the Arduino to communicate with other devices such as smartphones or tablets.

6) DC Water Pump (12V):



Fig 7 DC water Pump (12v)

A water pump powered by direct current (DC) with a voltage rating of 12V. It is used for pumping water in various applications such as irrigation or circulation systems.

7) Seed Roller:

The seed roller is a component used for dispensing seeds in agricultural applications. It may include mechanisms for controlling seed distribution and quantity.



Fig 8 Seed Roller

8) Battery (12V 2Ah):



Fig 9. Battery (12v, 2Ah)

A rechargeable battery with a voltage rating of 12V and a capacity of 2Ah (ampere-hours). It serves as a power source for the system, providing energy when the solar panel is not generating electricity.

9) Adapter (12V 2Ah):



Fig 10. Adapter (12v, 2Ah)

An adapter is used to convert alternating current (AC) from a power outlet into direct current (DC) suitable for powering electronic devices. The 12V 2Ah adapter provides a consistent voltage and current output.

10) High Torque DC Motor (100 RPM):



Fig 11. High Torque DC Motor (100 RPM)

A DC motor with high torque output suitable for applications requiring high rotational force. The 100 RPM rating indicates its rotational speed.

11) Chassis and Wheels:

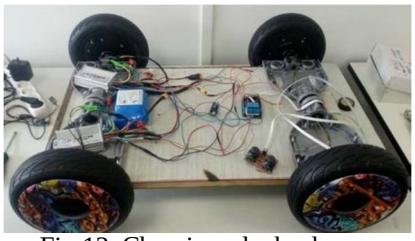


Fig 12. Chassis and wheels

The chassis is the framework or structure of the robot, providing support and housing for the electronic components. Wheels are attached to the chassis, allowing the robot to move.

12) Motor Driving Board (L293D):

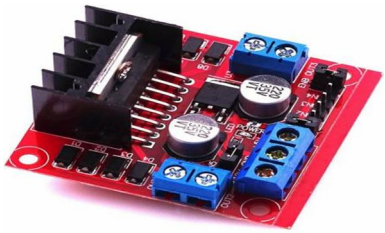


Fig 13. Motor Driver Board (L293D)

The L293D motor driver is an integrated circuit used to control the speed and direction of DC motors. It provides an interface between the Arduino and the motors, enabling precise motor control.

13) Relay Board (12V):



Fig 14. Relay Board (12v)

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A relay board is a module containing one or more relays, which are electrically operated switches. It allows the Arduino to control higher voltage or current devices, such as motors or pumps, safely.

The fabrication process for the solar seed sprayer machine commenced with precise 3D modeling using Auto-desk Inventor CAD software are as shown in fig16. Every component necessary for the machine was meticulously designed, ensuring accuracy and cohesion in the final product. Performance analysis calculations were conducted to anticipate the machine's efficiency, providing a foundation for its operational capabilities.

Upon completion of the modeling phase, the solar charging system underwent rigorous testing to ensure seamless integration and functionality. Operating at a consistent 12V voltage, the system powered the entire setup, incorporating a solar panel with a maximum power output of 20W and an 18V working voltage. Calculations revealed that a 12V-7Ah lead-acid battery discharged to 50% would require approximately 4 hours for full recharging. Subsequently, the fabrication continued with the construction of a waterproofed 12mm plywood seed storage container and the implementation of a dispenser mechanism inspired by a cereal dispenser design. Additionally, an impeller spreader system was developed and integrated into the machine, enhancing its efficiency.fig 15 shows the experimental trials, conducted to assess functionality, efficiency, and coverage area, involved the dispensing of various seeds and beans, thereby validating the machine's performance under diverse conditions.

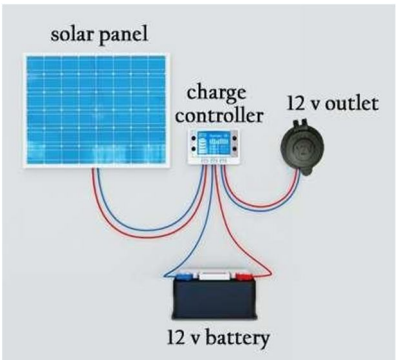
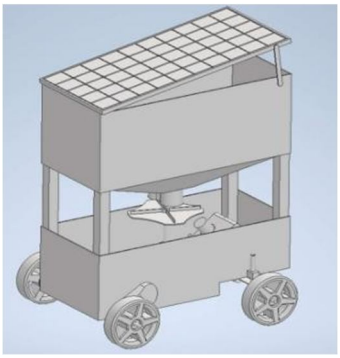


Fig 15 Solar panel connection


Fig 16 Manufactured Model 3D model

VI. RESULT & DISCUSSSION

Ten different types of seeds and beans, each weighing 100g, were prepared and dispensed by the machine to test seed spreading. The performance of the machine was observed and recorded in Table 1. It was noted that while most seeds and beans were successfully dispensed, some encountered occasional sticking issues. This was attributed to a design flaw in the dispenser mechanism, where seeds would occasionally become lodged between the spinning paddle and the wall. Despite the electric motor's torque of 4.5kg.cm, it proved insufficient to overcome this resistance consistently. However, with controlled flow rate adjustments, the majority of seeds could be dispensed, barring larger ones such as pumpkin seeds and chickpeas. Further modifications are deemed necessary to address these issues.

Subsequent experiments aimed to evaluate the seed dispense rate by activating the dispenser mechanism for 10 seconds, after which the dispensed seeds were collected and weighed. The results are depicted in Figure 17.

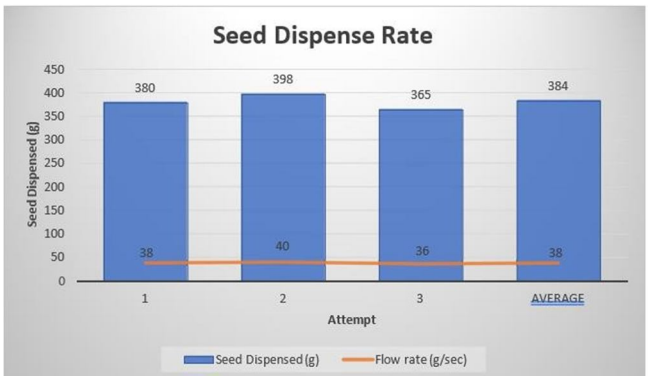


Fig.17 Seed dispense rate experiment data

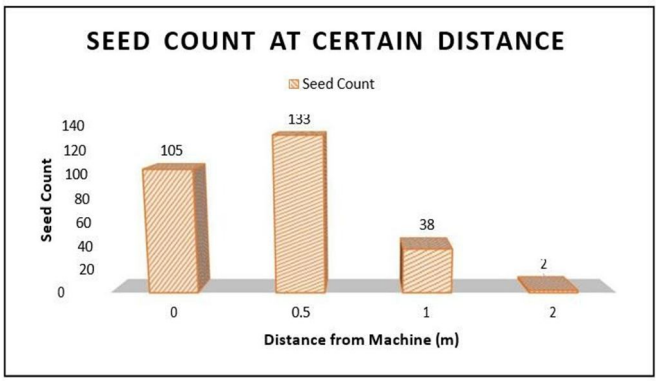


Fig.18 Average Outcome of seed spreading area

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Table 1 Table 1 Capability of Seed Sprayer Machine on Different Types of Seeds

Types of seeds	Size & Shape	Potential
Sesame Seed		Dispense smoothly and seeds leaked when the machine was not operated.
Wheat Seed		Working but occasionally stuck
Rice		Dispense smoothly
Cracked Corn		Dispense smoothly
Pumpkin Seed		Stuck and may crush the seed
Green Bean		Dispense smoothly
Red Bean		Working but occasionally stuck
Soybean		Working but occasionally stuck
White Bean		Working but occasionally stuck
Chickpeas		Totally stuck in mechanism

The results indicate that the average dispense rate of the machine is approximately 38g/sec at maximum motor speed. In the final set of experiments, the spreading area covered by the machine was tested. Distances of 0.5, 1.0, 1.5, and 2 meters from the machine were chosen for evaluation. The machine ran for 10 seconds, and the seed count was recorded at each distance. This experiment was repeated for accuracy and consistency.

Three different attempts were made, and the average outcome was considered for accuracy. The most effective distance from the machine was found to be 0.5 meters, while the maximum distance was 2.5 meters. Given that the seed spraying follows a circular pattern with the machine at the center, the effective area covered by the machine was approximately 3.14 square meters. Figure 18 illustrates the average outcome of the seed spreading coverage area.

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VII. CONCLUSION

The proposed seed spreading machine has demonstrated remarkable success in achieving the objectives outlined for this project. It operates solely on solar energy, aligning with sustainability goals by reducing reliance on non-renewable resources. With a focus on dispensing small and medium-sized seeds and beans, the machine has showcased impressive capabilities, achieving a maximum spreading rate of 1353 seeds per second. Moreover, its operational efficiency extends to covering an area of 3.14 square meters along its running path.

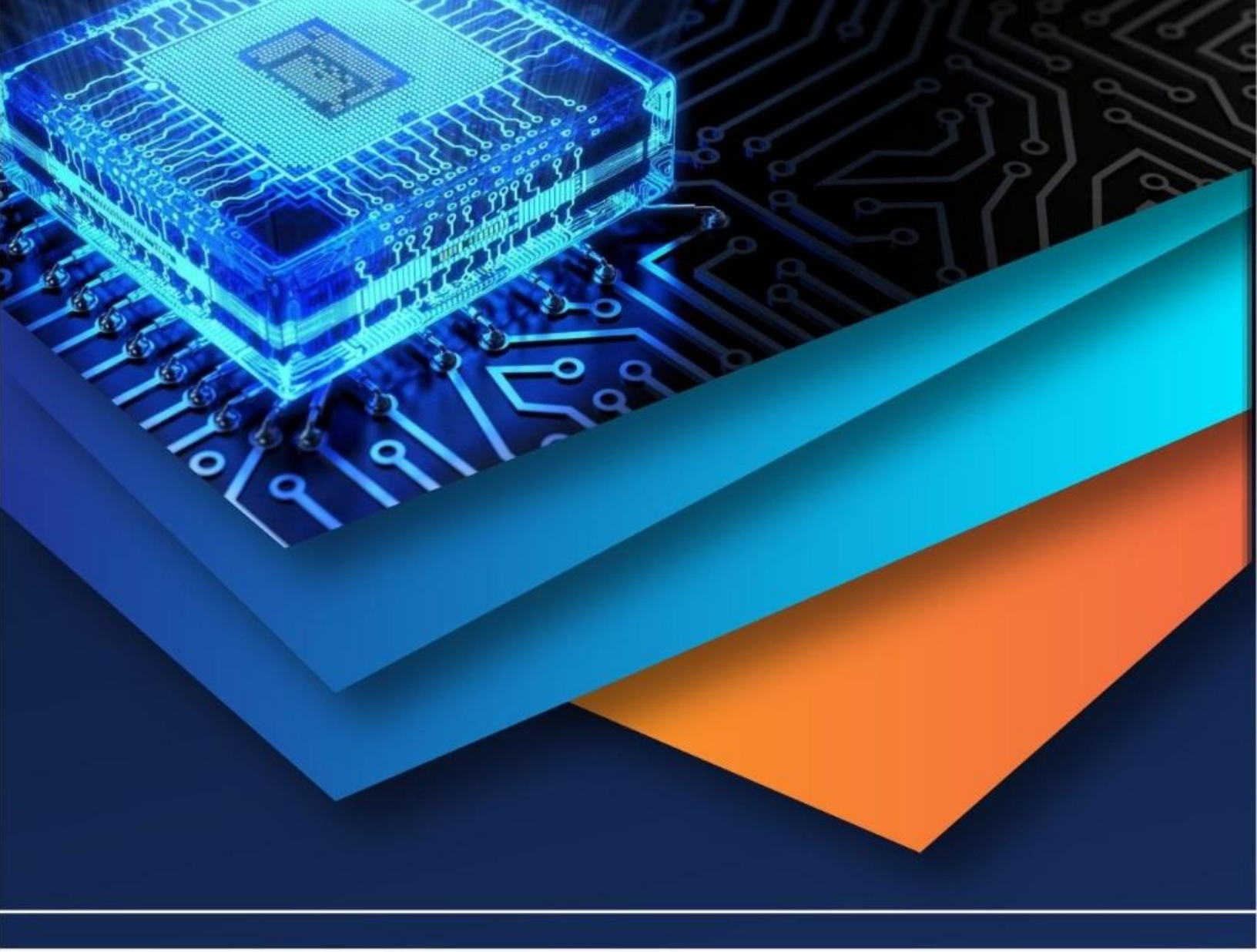
By harnessing renewable energy for agricultural purposes, this machine epitomizes a practical implementation of the Sustainable Development Goals (SDGs). Specifically, it contributes to SDG 7 (Affordable and Clean Energy) by utilizing solar power, thereby promoting access to affordable, reliable, sustainable, and modern energy for all. Furthermore, its application in agriculture aligns with SDG 1 (No Poverty) by enhancing productivity and efficiency in farming practices. By automating seed spreading tasks and increasing coverage area, the machine aids in improving agricultural productivity, which is essential for poverty reduction and food security.

Overall, the solar seed sprayer machine represents a tangible step towards sustainable agriculture and poverty alleviation, embodying the principles of innovation, renewable energy utilization, and socio-economic development. Its success underscores the potential of technology-driven solutions in addressing global challenges and advancing towards a more sustainable future.

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