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Design & Fabrication of a Solar Powered Seed Sprayer Machine

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Abstract -

The rapid advancement of modern technology has significantly influenced all sectors, including agriculture. To meet the increasing global food demand, it is essential to adopt innovative farming techniques that enhance crop productivity without degrading soil quality. This project focuses on the design and development of a solar-powered, remote-controlled seed sowing machine with an integrated spraying system. Traditional seed sowing methods in India such as manual labor and animal-driven operations are time-consuming and result in low productivity, while tractor-based systems rely on fossil fuels, contributing to environmental pollution and energy depletion. To address these challenges, the proposed system utilizes clean and renewable solar energy, thereby reducing operational costs, labor dependency, and environmental impact. The machine operates using a solar panel that converts sunlight into electrical energy, which is stored in a 12V battery. This energy powers a DC motor responsible for driving the system. Additionally, IR sensors are incorporated to enable automated navigation and field coverage. The system is capable of performing multiple agricultural operations, including digging, seed sowing, and spraying, while adapting to varying ground conditions. Overall, the proposed solution offers an efficient, eco-friendly, and cost-effective approach to modern agriculture, contributing to sustainable farming practices and improved crop yield.

Keywords:

- Solar-powered agriculture
- Seed sowing machine
- Remote-controlled robot
- Smart farming
- Precision agriculture
- DC motor drive system
- IR sensor navigation
- Automated irrigation / spraying
- Sustainable farming
- Renewable energy applications
- Agricultural robotics
- Cost-effective farming technology

1.INTRODUCTION

Introduction (15 Lines)

Agriculture has long been the backbone of the Indian economy and continues to play a vital role in sustaining the nation's population. India supports nearly 17% of the world's population with only 2.3% of global land and 4.2% of water resources, making efficient farming practices essential. The current cropping intensity of about 137% reflects the increasing demand for higher productivity from limited land. Proper sowing is a critical agricultural operation that ensures seeds and fertilizers are placed at the correct depth, spacing, and alignment for optimal crop growth. Traditional seed sowing methods, such as manual broadcasting and plough-based techniques, are labor-intensive, time-consuming, and often result in uneven seed distribution. These limitations highlight the need for improved and mechanized sowing systems. Modern seed sowing machines aim to enhance precision, reduce labor, and improve overall efficiency in farming operations. Additionally, integrating multiple functions such as seed placement and fertilizer application in a single machine can significantly reduce operational costs and time.

With the growing energy demand and environmental concerns, renewable energy sources like solar energy

have gained importance in agricultural applications.

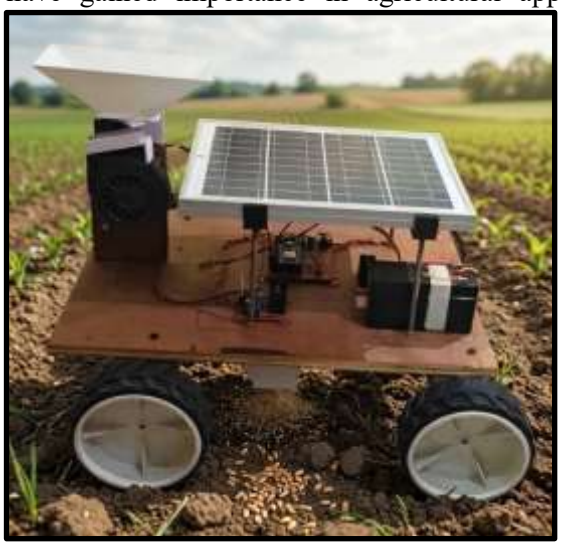

Fig.1: Solar powered seed sprayer machine

Solar energy is clean, safe, and increasingly cost effective compared to conventional energy sources.

DESIGN COMPONENTS

Solar panel

A solar panel, also known as a photovoltaic (PV) module, is made up of multiple solar cells that convert sunlight into electrical energy.
It works on the photovoltaic effect, where sunlight (photons) generates direct current (DC) electricity. Solar panels are composed of semiconductor materials like silicon, with layers of phosphorus and boron to create charge flow.

Fig.2: Solar panel

They provide clean, renewable energy and can power homes, devices, and agricultural systems.
In practical systems, solar panels may be connected to batteries and inverters to store energy and convert DC into usable AC power.

12v Battery

A battery is made up of multiple cells connected in series, typically producing about 12.6 volts when fully charged.
Each cell contains two lead plates (positive and negative) separated by an insulating material and immersed in an electrolyte.

Fig.3: Battery

Primary batteries are single-use, while secondary batteries can be recharged multiple times. Common rechargeable types include lead-acid batteries (used in vehicles) and lithium-ion batteries (used in electronics). Batteries vary in size, from small cells in watches to large battery banks for backup power systems. In a typical 12V battery, six cells work together to generate electricity through chemical reactions. A fully charged battery shows around 12.6–12.8V and may take several hours to recharge safely.

Charge controller

A charge controller is a device that regulates the flow of electrical current to and from a battery, ensuring safe and efficient operation. It prevents overcharging, overvoltage, and deep discharging, which can damage the battery and reduce its lifespan. Commonly used in solar and wind energy systems, it plays a vital role in maintaining battery health and system reliability. There are different types of charge controllers, such as series and shunt regulators, each with specific working

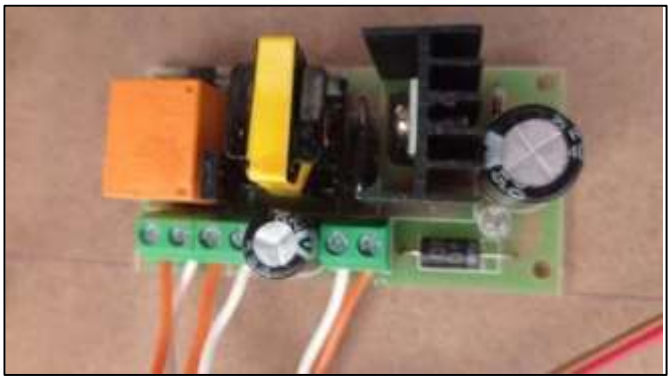

Fig.4: Charge controller

methods. Advanced technologies like PWM (Pulse Width Modulation) and MPPT (Maximum Power Point Tracking) enhance charging efficiency and performance. Additionally, modern charge controllers may include features like temperature monitoring, data display, and logging functions to track energy usage.

Arduino

The **Arduino Nano** is a compact, breadboard-friendly microcontroller board based on the ATmega328P, introduced in 2008.
It provides similar functionality to the Arduino Uno but in a smaller size, making it suitable for embedded projects. The board supports UART serial communication through digital pins 0 (RX) and 1 (TX), with USB communication handled by the FT232RL chip.

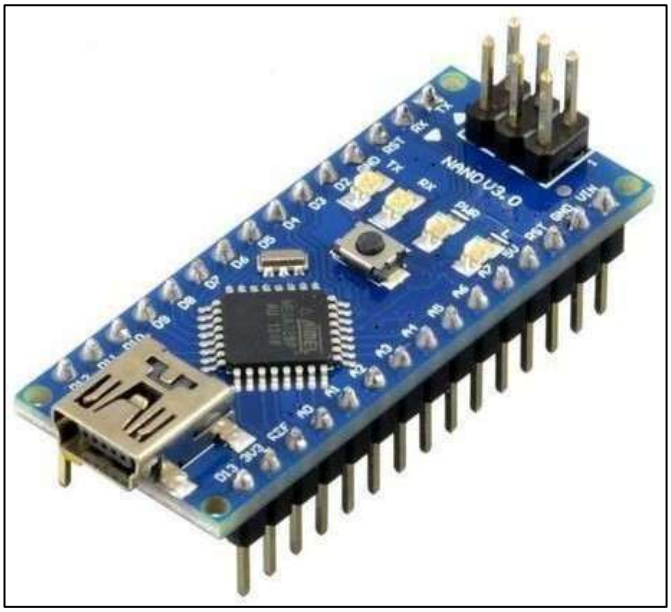

Fig.5: Arduino

It also supports I2C and SPI communication using built-in libraries like Wire in the Arduino IDE. Arduino Nano has 14 digital I/O pins (6 PWM) and 8 analog input pins for versatile interfacing. It operates at 5V, accepts 6–20V input, and can be powered via micro-USB or external supply. The board includes 32 KB flash memory and allows easy programming using the Arduino IDE for various applications.

Driver (L298N)

The L298N Motor Driver Module is a high-power motor driver used to control DC and stepper motors in various applications. It is built around the L298 motor driver IC and includes a 78M05 voltage regulator for efficient power management.

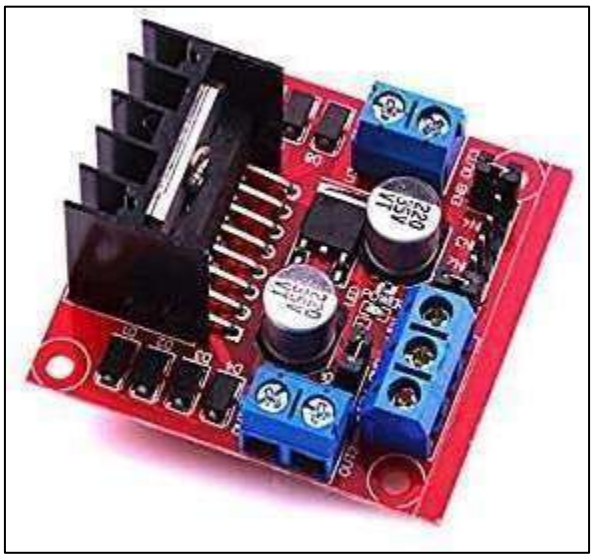

Fig.6: Driver (L298N)

The module can drive up to four DC motors or two DC motors with both speed and direction control. The ENA and ENB pins are used to control the speed of Motor A and Motor B, while IN1–IN4 pins are used to control their direction. The 78M05 regulator is activated only when the jumper is connected and the supply voltage is less than or equal to 12V. If the supply voltage exceeds 12V, the jumper should be removed and an external 5V supply must be provided. This module is widely used in robotics, automation systems, and motor control projects.

Servo motor

A servo motor is a rotary actuator that provides precise control of angular position, speed, and acceleration. It consists of a DC motor, gears, a control circuit, and a position sensor such as a potentiometer or encoder.

Fig.7: Servo motor

It operates on the PWM (Pulse Width Modulation) principle, where the pulse duration determines the shaft position. Servo motors work as closed-loop systems, continuously comparing actual position with the desired input. If there is a difference, an error signal is generated to correct the position. The motor rotates until the error becomes zero and then holds the required position. Due to high accuracy and control, servo motors are widely used in robotics, automation, and control systems.

60 rpm DC motor

A 60 RPM DC motor is a low-speed electric motor that rotates at 60 revolutions per minute. It is commonly used in applications requiring high torque and controlled speed. This motor typically operates on DC power and includes a gearbox to reduce speed and increase torque.

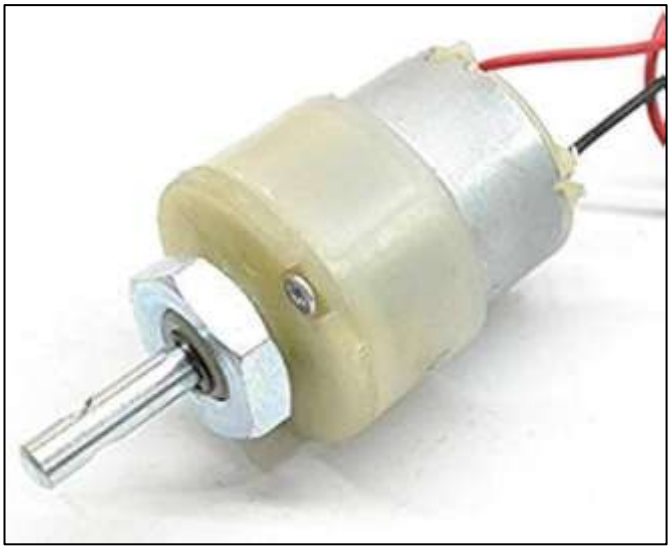

Fig.8: 60 rpm DC motor

It is widely used in robotics, conveyor systems, and automation projects. The motor provides stable and consistent rotation, making it suitable for precise operations. Its compact size and efficiency make it ideal for small-scale mechanical systems. 60 RPM DC motors are easy to interface with microcontrollers like Arduino for various control applications.

Relay

A relay is an electrically operated switch used to control circuits by using a low-power signal to operate a higher-power circuit. It consists of input terminals for control signals and output terminals for switching operations. Relays can have different types of contacts such as normally open, normally closed, or combinations of both. Traditional relays use an electromagnet to open or close the contacts, while modern versions may use solid-state components without moving parts.

Fig.9: Relay

They are widely used in automation, protection systems, and control applications. Additionally, special types like latching relays can maintain their state even after the control signal is removed, making them useful in various electrical and electronic systems.

AI BLYNK MOBILE

Fig.10: AI Blynk

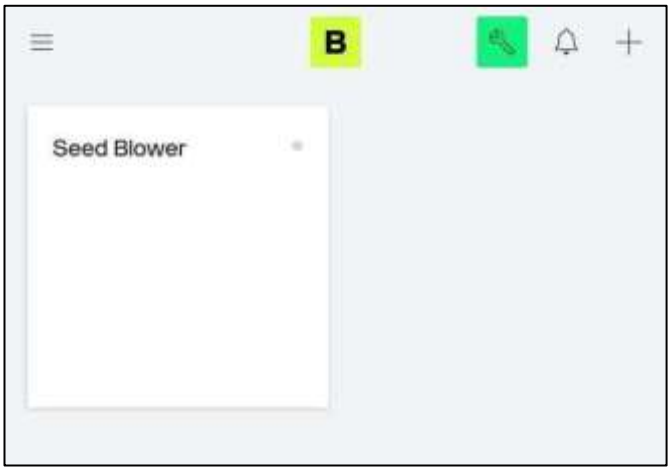

Fig.11: AI Blynk App

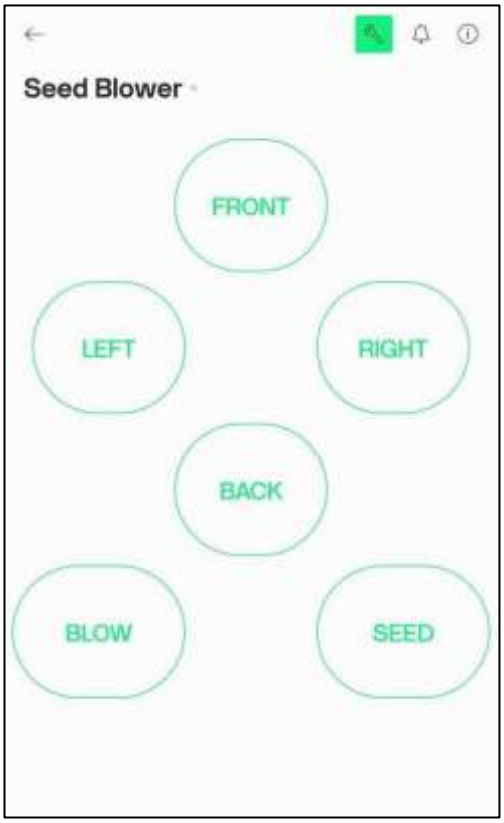

Fig.12:AI Blynk Seed blower controller

Wheels

A wheel is a circular mechanical device designed to enable smooth movement by rolling, making it easier to transport objects. It is considered a simple machine that reduces effort through mechanical advantage. In most land vehicles, wheels are used in pairs and are connected by an axle, allowing them to rotate together.

Fig.13: wheels

Some wheels are designed with teeth, known as gears, to transmit motion in machines. In this system, four-disc wheels of 50 mm diameter are used for movement. The motion of the machine depends on the rotation of these wheels, which are driven by a motor. When the motor rotates in the forward direction, the wheels also rotate, causing the entire machine to move forward.

Construction

Literature Review

Heege and Feldhaus (2002) [1]:
Proposed a **site-specific control system** for grain drills that adjusts the number of seeds per unit area based on field conditions. This approach improves **precision farming**, ensuring optimal seed distribution and better crop yield.

Sawalakhe et al. [2]:
Focused on the **design and development of agricultural machinery** aimed at reducing human effort and improving efficiency. Their work highlights the importance of **mechanization in modern agriculture**, particularly in seed sowing applications.

Sahay (1990) [3]:
In the book *Principles of Agricultural Engineering*, fundamental concepts of agricultural tools and machinery are discussed, including **seed sowing techniques, machine components, and performance**

factors, providing a strong theoretical base for sowing equipment design.

Rahuri Agricultural R&D Department [4]:
Developed a **horizontal seed metering mechanism** that ensures uniform seed distribution. This innovation enhances **accuracy in seed placement** and reduces wastage during sowing operations.

Joshua, Vasu and Vincent (2010) [5]:
Introduced a **solar-powered agricultural sprayer**, demonstrating the potential of renewable energy in farming. The system reduces dependency on fossil fuels and promotes **eco-friendly and cost-effective agricultural practices**.

Pundkar and Mahd (2013) [6]:
Presented a comprehensive review of sowing machines, emphasizing the role of **precision planters** in achieving uniform seed spacing and depth. Their study highlights the importance of **advanced sowing technologies** in improving productivity.

Raut et al. (2013) [7]:
Designed and fabricated a **multi-purpose agricultural machine** integrated with pesticide spraying and weeding functions. This system reduces labor requirements and increases **operational efficiency** in farming.

Ramesh and Girishkumar (2014) [8]:
Provided a detailed review of various **seed sowing equipment**, focusing on mechanisms such as **seed metering devices, power transmission systems, and furrow openers**. The study emphasizes proper seed placement for better germination and yield.

Sawalakhe et al. (2015) [9]:
Developed a **solar-powered seed sowing machine** that combines renewable energy with automation. The system ensures **uniform seed distribution, reduced labor, and energy efficiency**, making it suitable for small-scale farmers.

Sridhar H. S. (2013) [10]:
Designed a **single-wheel manually operated multi-use weeder**, which can also assist in sowing operations. The machine is simple, cost-effective, and reduces manual effort, making it ideal for rural agricultural applications.

Results

The solar-powered seed sprayer was successfully tested under real field conditions and demonstrated efficient performance. The system operated smoothly using solar energy, while the rechargeable battery provided reliable backup during low sunlight

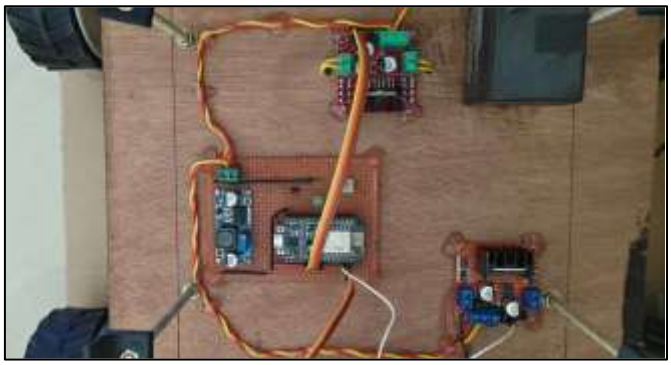

Fig.14

conditions, ensuring uninterrupted operation. The ESP32-based control system maintained stable motor performance and enhanced overall system reliability. The centrifugal fan enabled uniform and controlled seed distribution across the field.

Fig.15

Compared to traditional manual seeding methods, the developed model significantly reduced seed wastage and minimized physical effort.

Fig.16

Additionally, the lightweight design improved ease of handling, and the sturdy construction ensured durability. Overall, the results confirm that the solar-powered seed sprayer is an efficient, cost-effective, and user-friendly solution suitable for small and medium-scale agricultural applications.

Conclusion

The integration of AI BLYNK Mobile technology into solar-based seed sprayer
machines offer several significant benefits for agricultural operations. By
leveraging Bluetooth connectivity, these machines can enable seamless
communication and control between the sprayer and external devices such as
smartphones or tablets. This allows for remote monitoring and management of
seeding activities, enhancing efficiency and convenience for farmers. Moreover,
Bluetooth technology facilitates data exchange and analysis, enabling farmers to
gather insights into seeding operations and optimize performance over time.
Real-time data on seed distribution, field conditions, and equipment status can
be transmitted wirelessly, empowering farmers to make informed decisions and improve productivity.

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