# Solar Powered Agri Robot

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***Abstract*—In a country like India, where close to 70% of the population depends on agriculture for their livelihood, there is a growing need to make farming smarter, more sustainable, and less physically demanding. Tasks such as sowing seeds and watering crops may seem simple, but they require long hours of manual labor, especially under harsh weather conditions, and often lead to fatigue, inefficiency, and uneven crop output. While there are modern machines that can automate these processes, they are usually too costly, bulky, or complex for small and marginal farmers who form the backbone of Indian agriculture. To address this gap, this project introduces a solar-powered farming robot that makes seed sowing and watering easier, faster, and more consistent. It is designed to be affordable, lightweight, and energy-efficient, drawing its power from a solar panel, which allows farmers to use it even in remote villages with limited or no electricity. What sets this robot apart is its user-friendly control system—farmers can operate it using a basic Android app over Wi-Fi, giving them complete control over the robot's movement and functions without needing any technical skills. This means that even those unfamiliar with modern technology can benefit from it. Unlike fully autonomous systems that may require complex setup, this robot keeps the human in the loop, allowing flexibility while still reducing labor. It helps farmers cover more land in less time, ensuring timely sowing and watering, which are critical for a good harvest. The robot not only makes farming less physically demanding but also encourages the use of clean energy and digital tools in rural areas. By bringing together simplicity, sustainability, and practicality, this solution empowers farmers to work smarter, save time and energy, and ultimately improve crop yield and livelihood—making agriculture not just a tradition, but a profession of innovation and dignity.**

***Index Terms*—Agriculture, seed sowing, watering system, Wi-Fi controlled robot, solar powered, manual operation.**

## I. INTRODUCTION

Agriculture has been the backbone of human civilization for thousands of years, evolving through generations, shaped by changing climates, diverse cultures, and technological advancements. Yet, despite this long history, many farming practices today still rely on manual labor and traditional methods, which can be time-consuming, physically exhausting, and inefficient—especially for small and marginal farmers. To address these challenges and support the people who feed our nation, there is a growing need to modernize agricultural systems with smart, user-friendly technology. This project presents an innovative robotic model designed to automatically carry out essential tasks like seed sowing and watering, significantly reducing the effort required from farmers. The prototype acts as a stepping stone toward advanced, tech-assisted farming by integrating automation into daily agricultural routines. Controlled and guided by basic commands, the robot efficiently sows seeds and waters them with precision, ensuring uniformity and saving both time and resources. By combining robotics with basic automation, this system brings a modern touch to traditional farming, offering a practical solution that boosts productivity, reduces manual labor, and supports sustainable agriculture. This kind of advancement not only improves the way crops are grown but also empowers farmers with tools that make their work easier, more efficient, and more rewarding.

## II. RELATED WORKS

As there are no efficient equipment's to aid the farmers. There is a need for new techniques to be implemented. Once the idea was formulated, design

options were finalized
In[1],Saurabh Umarkar and Anil Karwankar, discussed that the process of seed sowing is a key component of agriculture field. For many crop varieties ,high-precision pneumatic planting has been developed for a wide range of seed sizes, resulting to uniform seed distribution in seed spacing along the travel path. Wifi is used as receiver. Main disadvantage of the system is robot moves in only one direction. Whenever there is obstacle power supply is automatically turned OFF.

In[2],M.D.I.Sujon,R.Nasir and Jayasree Baidya, agricultural researcher determined the effects of various seeding techniques and machines and also different rates of oil seed rape application on establishment of seed emergence plant and final yield of grain. The robot will perform farming using analogy of ultrasonic detection in order to change its position. The main disadvantage of this system is ,it does not work well on all types of soil.

In[3],H.PotaREaton, JKatupitiya and SDPathirana, concludes that bullock drawn planting becomes a necessity to sow as skilled sowing workers are almost decreasing. Planting distance and plant population are acute factors in maximizing the yield of crops.In this Microcontroller 8051isusedfor communication between the input and output devices. The main drawback of this model is, it consists of only one mechanism. In[4],S.Kareemulla, KShaik, EPrajwal, BMahesh, VReddy, the system benefits farmers in the basic operation of seed sowing. This machine's operating mode is simple. It is possible to increase the totall yield percentage effectively. Labour problem can be reduced.As compared to the manual and tractor based sowing time and energy required for this robot machine is less. Also wastage of seed is less. The disadvantage of model is, it consists of only one mechanism.

The above research papers helped to understand the different aspects posed by the research on the agricultural robot. The robots designed in the above literature surveys have many issues with movement of the robot and grass cutting. These problems are effectively addressed in this work.

## III. BLOCK DIAGRAM

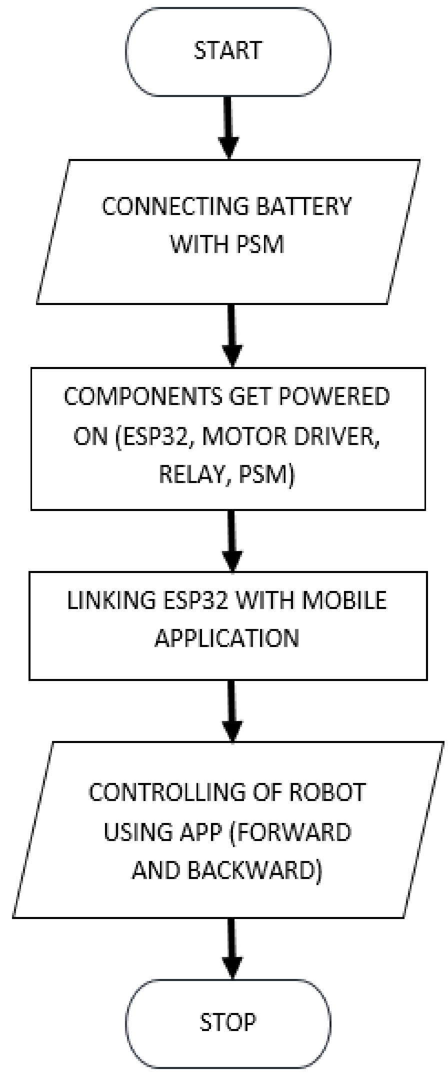


Fig.1. Block diagram of the Seed Sowing and Watering system Robot.

The block diagram outlines the step-by-step working of a mobile-controlled agricultural robot system powered by an ESP32 microcontroller. The process begins with connecting the battery to the Power Supply Module (PSM), which is responsible for distributing the required power to all components. Once connected, essential modules such as the ESP32 microcontroller, motor driver, relay, and the PSM itself are powered on. After initialization, the ESP32 establishes a wireless link with a mobile application, typically over Wi-Fi or Bluetooth. This connection enables the user to manually control the robot in real time using their smartphone. The app sends commands—such as moving forward or backward—which the ESP32 processes and forwards to the motor driver to actuate the wheels accordingly. This setup allows the robot to perform basic navigation tasks in the field, making it suitable for operations like seed sowing and watering.Finally, the process ends when the robot is stopped, either through the mobile app or by disconnecting the power source, completing the cycle of control.

I. ESP32

The ESP32 is a highly versatile and powerful microcontroller developed by Espressif Systems. It is widely used in a variety of applications ranging from IoT (Internet of Things) projects to smart home devices, robotics, and more. The ESP32 offers significant improvements over previous microcontrollers like the ESP8266, mainly due to its increased performance, integrated Wi-Fi, Bluetooth, and various other advanced features.

Fig.2.ArchitectureofESP32.

II. SolarPanel

The solar cells that are seen on satellites and calculators are also called photo voltaic(PV) cells as shown in Fig.3, which as the name implies (photo meaning \light" and voltaic meaning \electricity"), convert solar energy directly into electrical energy. A module is a group of cells which is electrically connected and packed into a frame (most commonly referred as solar panel). Solar panels are a great way to cut your electricity that everyone wants to live on their own or at least reduce our home’s carbon footprint, and solar panels make this dream possible. Solar panels are made of photovoltaic a (PV) cell, which converts sunlight into electricity.


Fig.3.Solarpanel.

III. . Motor Driver IC L293D

The motor driver module is an essential component in any robotic or automated system where precise control of DC motors is required. In this project, the motor driver is based on the L293D integrated circuit (IC)**,** a robust and versatile 16-pin dual H-bridge driver that enables the control of two DC motors independently. It serves as a bridge between the low-power control signals from the microcontroller (like the ESP32) and the high-power requirements of the motors. The L293D is specifically designed to handle bidirectional currents and is capable of operating with voltage levels ranging from 5V to 36V**,** making it suitable for a wide range of applications, from small hobby robots to more demanding field robots. Each side of the IC can control one motor, with four input pins accepting logic signals that determine motor direction, four output pins connected to the motors themselves, and two enable pins that act as activation switches for each motor. By changing the logic levels at the input pins, the motors can be driven forward, in reverse, stopped, or even braked electronically. This level of control is especially useful in agricultural robots, where direction and movement must be carefully managed for tasks like following rows, turning around corners, or stopping at precise positions for sowing seeds or watering crops. Moreover, the L293D has built-in diodes to protect against back EMF generated by the motors, increasing the reliability and lifespan of the system. Its compact form factor, combined with its ability to drive two motors simultaneously with independent control, makes the L293D a cost-effective and practical solution for embedded robotic systems where real-time, efficient motor control is critical to performance and task execution.

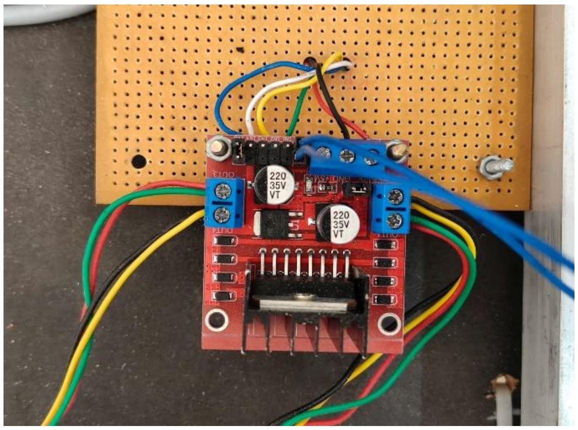

Fig.4.Motor Driver.

## IV. POWERSUPPLYMODULE

When working with the ESP32 microcontroller, providing a stable and appropriate voltage supply is absolutely crucial to ensure smooth and reliable operation. The ESP32 typically operates at 3.3Vlogic level, meaning its internal components and I/O pins are designed to work within this voltage range. However, it is versatile in terms of power input and can be powered in different ways depending on the project setup, power availability, and components used. One of the most common and user-friendly options is powering the ESP32 through its micro-USBport, which is connected to an onboard voltage regulator that safely steps down the 5VinputfromtheUSB to the required 3.3V. This method is especially useful during development and programming stages.

In more embedded or battery-powered applications, you might use a Li-ion or Li-Po battery along with a power supply module (PSM) like the AMS1117 or MB102, which regulate the voltage down to a safe 3.3V output. The AMS1117-3.3 is particularly popular in DIY and robotics projects due to its simplicity and ability to convert voltages like 5V or 12V down to 3.3V, making it ideal for field applications where USB access isn't practical. Another option includes using buck converters (step-down voltage regulators)such asLM2596, which are efficient and adjustable, suitable for situations where you need to drop from higher input voltages without generating too much heat.

Some custom PCBs or breakout boards designed for ESP32 already integrate such regulators and allow for multiple input voltage ranges, which adds flexibility for integrating with solar panels, batteries, or power adapters. It's also important to note that while powering the board, care must be taken not to apply more than 3.3V directly to the GPIO pins, as this could permanently damage the microcontroller. Ensuring a clean and regulated voltage not only protects the ESP32 but also ensures stable communication with peripherals like sensors, relays, and motor drivers. In summary, choosing the right power supply method—be it via USB, regulator module, or direct battery connection—depends on the project's power source, form factor, and portability requirements, but all serve the same essential purpose: keeping the ESP safely and efficiently powered.

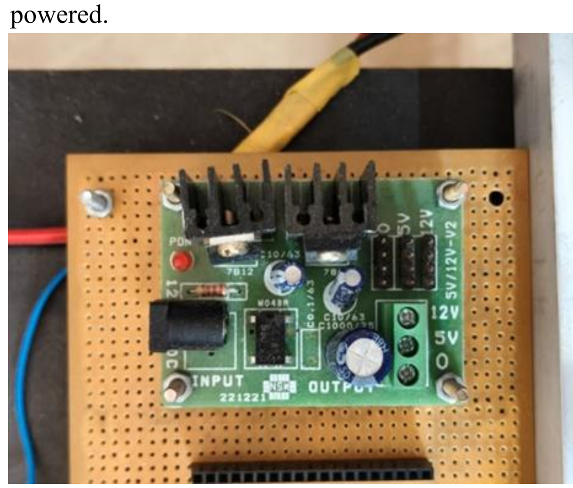

Fig. 5. Power Supply Module

## V. RELAY

A relay is an electromechanical or solid-state device that functions as a switch, enabling the control of one electrical circuit by another, typically using a low-power signal to govern a high-power circuit. It plays a crucial role in systems where electrical isolation between the control and the output is necessary. Relays are widely employed in a variety of domains, including automation, telecommunications, transportation, power systems, and consumer electronics. In electromechanical relays, the switching mechanism is actuated by an electromagnetic coil, allowing the physical movement of contacts to open or close a circuit. Solid-state relays, by contrast, utilize semiconductor components and offer faster operation with no moving parts, making them suitable for high-speed or vibration-sensitive environments.

Relays provide numerous functional advantages, including electrical isolation, load switching, and circuit protection. In industrial applications, they are essential for managing complex operations involving multiple devices and timing sequences. Historically, relays were foundational components in early computing and telephone exchanges, where they were used to implement logic operations and signal routing. Although many of their functions have been supplemented or replaced by transistors and integrated circuits in modern electronics, relays continue to be favored in applications requiring robust switching, high current handling, or galvanic isolation. Their versatility, reliability, and simplicity of operation make them an enduring and indispensable component in electrical and electronic systems.

## VI. METHODOLOGY

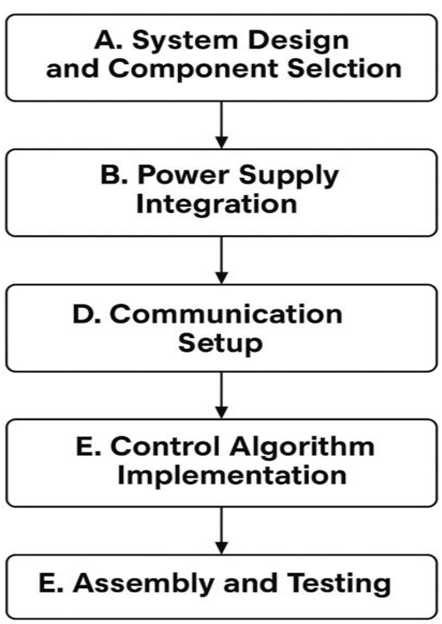


Fig. 6. Methodology to be adopted

## VII. IMPLEMENTATIONOFALGORITHM

STEP1: Start
The system is powered and all components are initialized for operation.

STEP2: Switching ON the Robot
Power is supplied to the ESP32-based control unit, sensors, and actuators. The firmware begins execution and initializes all peripherals.

STEP3: Pairing the IoT Module (ESP32) with the Mobile Phone
The ESP32 establishes a wireless connection via Bluetooth or Wi-Fi with the Android mobile application. Successful pairing is confirmed through LED indication or a message prompt in the app.

STEP4; Robot Waits Until It Receives a Signal from the App
The system enters a standby mode and continuously listens for incoming commands from the mobile application.

STEP5: If a Signal Is Received, Customize the Functionality of the App Buttons
Upon receiving the signal, the application interface updates to allow the user to control specific robot actions such as seed sowing, watering, movement, or stopping.

STEP6: If the Signal Is Not Received, Go Back to Step 4
The ESP32 continues to poll or listen for an incoming signal from the app. This loop ensures the robot does not proceed until a valid connection and command are received.

STEP7: After Use, Disconnect the System from the Power Source
Once the desired agricultural operations are completed, the robot is turned off manually or via app instruction, disconnecting it from the power supply to preserve energy and ensure safety.

STEP8: Stop
The operation cycle ends, and the robot shuts down completely.

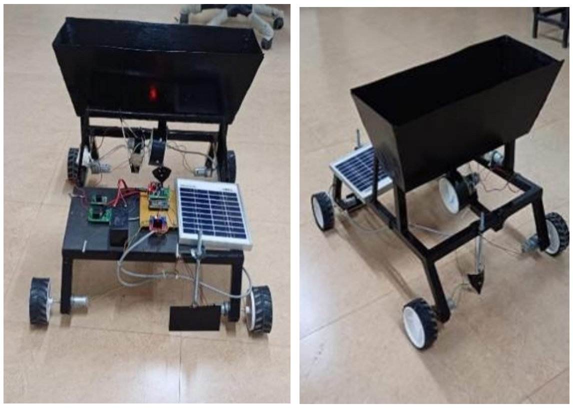

Fig. 7 Solar powered agri robot

## VIII. BLYNK IOT APP INTEGRATION

The agricultural robot is controlled wirelessly using the Blynk IoT application, which provides a user-friendly interface for real-time monitoring and control. The ESP32 microcontroller is connected to the Blynk platform via Wi-Fi, allowing seamless communication between the robot and the Android app.Using the Blynk app, users can remotely start and stop operations like seed sowing, water spraying, and weed cutting with a single tap. Virtual buttons and sliders are configured in the app to control relays and motor actions. The real-time status of each function can be displayed using widgets like LED indicators, terminal logs, and labels. Blynk's cloud connectivity ensures that the robot can be operated from anywhere, as long as an internet connection is available. This feature makes the robot highly flexible and suitable for use in large farms or remote fields. Overall, the integration with Blynk IoT enhances the robot's usability and makes it a practical solution for smart farming through wireless automation and remote control.


Fig. 8 App interface

## IX. CONTROL AND PROCESS OF CONNECTINGESP32 WITH BLYNK IOT APP

To enable seamless wireless operation of the agricultural robot, the ESP32 microcontroller is interfaced with the Blynk IoT platform, which provides a reliable and user-friendly solution for real-time monitoring and control via a smartphone. The setup begins with creating a project on the Blynk web dashboard, where essential credentials such as the Template ID, Device Name, and Auth Token are generated. These credentials are integrated into the ESP32 firmware to establish secure communication with the Blynk cloud. Using the Blynk mobile app, a virtual dashboard is designed by placing components like buttons, sliders, LED indicators, and terminal widgets, each linked to virtual pins (V0, V1, etc.) that correspond to GPIO pins on the ESP32. These GPIOs are connected to various actuators such as relays, motor drivers, and control units for seed sowing, water spraying, and weed cutting. The ESP32 is programmed using the Arduino IDE, with libraries like WiFi.h, BlynkSimpleEsp32.h, and Blynk.h to handle Wi-Fi connectivity and cloud integration. After uploading the code and powering the device, the ESP32 connects to the specified Wi-Fi and continuously listens for instructions from the Blynk server. When a user presses a button on the app, for instance, to start the water spray system, the Blynk server forwards that request to the ESP32, which in turn energizes the relay controlling the water pump. Similarly, commands for sowing seeds or cutting weeds are executed with precise timing and control. This allows for remote farming operations, especially useful in hard-to-reach or large agricultural areas, reducing labor and enhancing productivity. Additionally, real-time feedback such as system status or operational logs can be sent back to the app, giving users full visibility of the robot's activity. This combination of ESP32 and Blynk IoT results in a cost-effective, energy-efficient, and scalable smart farming solution that can be expanded with sensors and automation features in future versions.

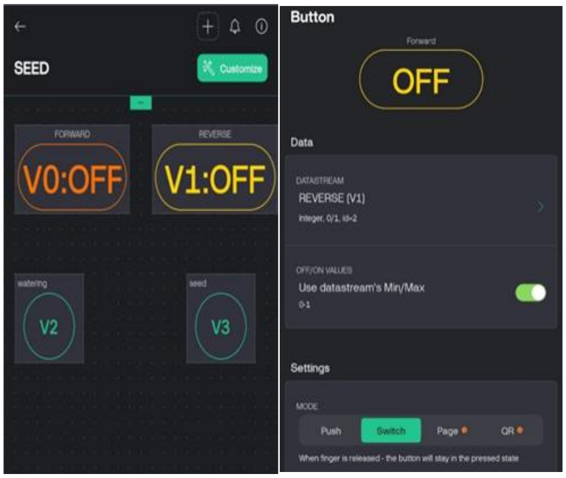


Fig. 9 Customization of app interface

The successful interfacing of the ESP32 microcontroller with the Blynk IoT platform enables efficient, wireless control of agricultural operations through a simple smartphone interface. This integration offers a reliable and cost-effective way to remotely manage functions like seed sowing, water spraying, and weed cutting. The real-time communication between the Blynk app and the ESP32 enhances user convenience and flexibility, making the system more intelligent and responsive. Overall, this IoT-based control system lays a strong foundation for scalable and smart agricultural automation.

## X. CONCLUSION

An agricultural robot is designed to perform the complex farming tasks like seed sowing and watering system.The benefits of robot are reduced human intervention and efficient resources utilization. Instructions are passed to the system using WI-FI which ensures no direct contact with human and thus safety of operator is ensured. The robot is solar powered hence it is renewable energy source. The operations are performed using android app. Innovative seed sowing, Watering system has significant influence in agriculture. By using this advanced work, farmer can save more time and also reduce lot of labour cost.

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