

# Design And Development Of Iot Based Agribot Solar Tracker

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**Abstract-** The Agri Bot Solar Tracker is a smart agricultural robot designed to support modern farming through automation and renewable energy. It performs agricultural tasks such as seed sowing and field monitoring using sensors to measure soil moisture, humidity, and temperature. The system uses Wi-Fi communication for remote monitoring and control through a monitoring and control station. Powered by solar energy with an integrated solar tracking system, the robot maximizes energy efficiency by adjusting the solar panel according to sunlight direction. This sustainable system reduces manual labor, improves operational efficiency, and promotes eco-friendly farming practices.

**Keywords:** IoT, Agribot, Solar Tracker, Smart Agriculture, Precision Farming, Soil Moisture Sensor, Renewable Energy, Wireless Monitoring, Agricultural Automation.

## I. INTRODUCTION

Traditional seed sowing methods in India are labor-intensive, time-consuming, and often expose workers to noise and vibration during tractor-based operations. To overcome these challenges, agricultural robotics and precision farming technologies have emerged to improve efficiency and reduce manual effort. The Agri Bot Solar Tracker is an autonomous agricultural robot designed for seed sowing and field monitoring using IoT technology.

It collects real-time data such as soil moisture, temperature, and humidity, enabling farmers to monitor crops remotely and make better decisions. Powered by solar energy and integrated with automation, the system promotes sustainable farming by reducing labor, improving productivity, and optimizing energy use.

In recent years, robotics in agriculture sector with its implementation based on precision agriculture concept is the newly emerging technology. The main reason behind automation of farming processes are saving the time and energy required for performing repetitive farming tasks and increasing the productivity of yield by treating every crop individually using precision farming concept.

Designing of such robots is modeled based on particular approach and certain considerations of agriculture environment in which it is going to work. These considerations and different approaches are discussed in this paper. Also, prototype of an autonomous agriculture robot is presented which is specifically designed for seed sowing task only.

## II. LITERATURE SURVEY

- Sunitha M: focused on seeding robotics for irrigation systems, highlighting that automation helps overcome labor shortages, rising costs, and water management issues in agriculture.
- M. Priyadarshini: developed a robot capable of soil moisture testing, seed sowing, pesticide spraying, and obstacle detection. The system used DTMF and Wi-Fi communication for better control and monitoring.
- Ankit Singh: proposed an agribot for seed sowing and ploughing using an Arduino controller and ultrasonic sensors for obstacle avoidance. The robot was remotely controlled and provided seed tank status updates.
- N.Firthous Begum: emphasized robotic harvesting systems to reduce labor costs and improve agricultural productivity by minimizing harvesting expenses.
- Buniyamin N: studied mobile robot path planning and explained static and dynamic navigation

methods for obstacle-free and changing environments.

### III. METHODOLOGY AND WORKING PRINCIPLE

#### A. Research and Requirement Analysis

A preliminary study was conducted to understand the challenges faced in traditional agricultural monitoring systems and identify the technological requirements for automation and sustainability. Existing literature on solar tracking mechanisms, IoT-based sensing systems, and autonomous robots was reviewed. Based on the findings, functional and non-functional requirements were defined, including energy efficiency, reliability, mobility, and data connectivity.

#### B. System Design

The system was divided into three main components: Mechanical Design: Focused on the structure and mobility of the robot, including the chassis, wheel arrangement, and mounting for the solar panel and sensors. Electrical Design: Included the design of the power system using solar panels, charge controllers, batteries, and a solar tracking module to ensure efficient energy harvesting. IoT and Control Design: Covered the integration of microcontrollers, sensors, and wireless communication modules for data acquisition and remote monitoring.

#### C. Hardware Development

The hardware implementation involved assembling the components of the robot, which included: Solar Panel and Tracker: A dual-axis solar tracker controlled by light-dependent resistors (LDRs) and servo motors to maintain optimal alignment with the sun. 8 SENSORS: Soil moisture, temperature, humidity, and light intensity sensors connected to a microcontroller (e.g., Arduino or ESP32). Power Unit: A solar charging circuit with a lithium-ion battery bank to store energy for continuous operation. Mobility System: DC or geared motors for movement across the field, controlled via motor driver modules.

#### D. Software Development

The software component consisted of: Microcontroller Programming: Embedded code to control sensors, solar tracking, and data transmission using platforms such as Arduino IDE or MicroPython. IoT Integration: Connection to a cloud platform (such as

Blynk, ThingSpeak, or Firebase) to enable remote data monitoring through mobile or web applications.

#### E. Integration and Testing

After assembling the hardware and completing the software, system integration was carried out. The robot's functionality was tested under different environmental conditions to evaluate: Solar tracking accuracy Energy efficiency and power management Sensor accuracy and reliability IoT connectivity and data transmission stability

### IV. FUTURE SCOPE

- GPS Integration: Adding GPS technology for accurate navigation and autonomous movement in agricultural fields
- AI-Based Crop Monitoring: Using Artificial Intelligence for disease detection, crop health analysis, and yield prediction.
- Advanced Sensors: Integrating additional sensors for nutrient monitoring, weather prediction, and pest detection.
- Automated Irrigation System: Connecting smart irrigation to automatically supply water based on soil moisture levels.
- Mobile App Integration: Developing a dedicated mobile application for real-time monitoring and remote control. Integrating a semi-mechanized version with a small rechargeable motor to reduce manual effort.
- Enhanced Solar Efficiency: Improving the solar tracking system for better energy harvesting and longer operation time.
- Multi-Tasking Capability: Expanding functions such as fertilizer spraying, weed detection, and harvesting.

### V. OBJECTIVES

- To develop a mobile robotic platform capable of autonomous movement across agricultural fields for continuous monitoring and data collection
- To design and integrate a dual-axis solar tracking system that adjusts the orientation of solar panels automatically to capture maximum solar energy throughout the day.
- To implement an efficient power management system that stores harvested solar energy in rechargeable batteries to ensure uninterrupted robot operation, even under low-light conditions.
- To integrate multiple environmental sensors (such as soil moisture, temperature, humidity, and light

intensity sensors) for real-time data acquisition and analysis.

- To enable IoT-based communication and data visualization by transmitting collected sensor data to a cloud-based platform or mobile application accessible to farmers.

## VI. RESULTS AND DISCUSSION

The developed Agri Bot Solar Tracker was successfully designed, fabricated, and tested for agricultural monitoring and seed sowing operations

**Solar Tracking Performance:**

The solar tracking mechanism effectively adjusted the position of the solar panel according to sunlight direction, improving energy utilization and ensuring continuous power supply for field operations

**IoT Monitoring:** The integrated IoT system successfully transmitted real-time sensor data through Wi-Fi communication, enabling remote monitoring of farm conditions and improving decision-making for farmers.

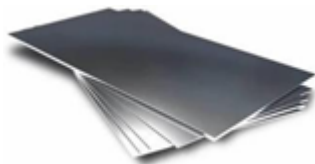


Fig. 1: Mild Steel Tubes



Fig. 2: Nylon Brush



Fig. 3: Plastic Wheels



Fig. 4: 25W DC Motor



Fig. 5: 12V Battery



Fig. 6: Button Switch

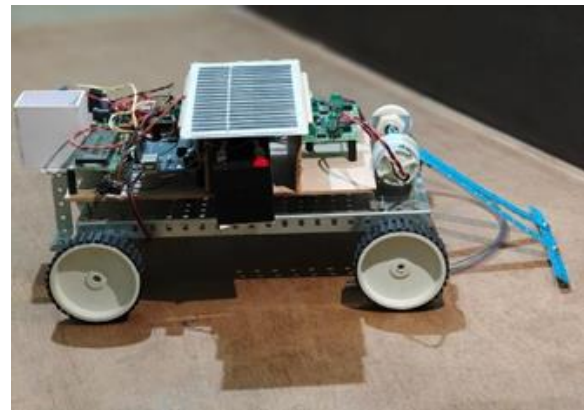


Fig. 7: Design and Development of IOT based AgriBot Solar tracker

The Use of Solar energy reduced dependency on external power sources, making the system energy-efficient and environmentally friendly. The lightweight design also improved portability and field usability.

**Cost Analysis:** Total fabrication cost was approximately

₹7,320 using locally available materials, making it affordable for rural and urban users. The absence of mandatory electrical components ensures usability in areas with limited electricity supply.

Table I. Cost Estimation

Component	Cost (₹)
Arduino Uno	450
Solar Panel (6V-12V)	300
Soil Moisture Sensor	120
Temperature and Humidity Sensor	150
Wifi Module (ESP 32)	1250
Motor Driver	250
DC Geared Motors	350
Rechargeable Battery	1700
Robot Wheels and Metal Frame	1500
Servo Mp	350
Battery Charger	900
Total	7,320

### A. Quantitative Performance Testing

Performance testing of the Agri Bot Solar Tracker was conducted under different environmental conditions to evaluate its efficiency in seed sowing, solar tracking, and sensor monitoring. The robot was tested for soil moisture sensing, temperature and humidity monitoring, mobility, and solar energy utilization. Multiple trials were performed to observe system accuracy and consistency. The results showed that the solar tracking system successfully aligned the solar panel toward sunlight, improving energy collection and maintaining continuous power supply. The soil moisture, temperature, and humidity sensors provided real-time data with reliable accuracy, helping monitor field conditions effectively. The robot also demonstrated smooth mobility and seed placement at specified intervals, reducing manual effort and improving operational efficiency.

### B. Comparative Evaluation

A comparison between traditional farming methods and the Agri Bot Solar Tracker was carried out. Traditional seed sowing requires high labor, more

time, and continuous human monitoring, whereas the Agri Bot reduces manual effort through automation and remote monitoring using IoT technology.

Unlike conventional methods, the Agri Bot provides real-time environmental monitoring, efficient energy utilization through solar power, and improved seed placement accuracy. The system reduces dependency on manual labor and external electricity, making it a more sustainable and cost-effective solution for smart farming.

### C. Structural and Durability Observations

During testing, the robot structure remained stable without any mechanical failure under normal operating conditions. The chassis, wheels, motors, and electronic components functioned effectively throughout the testing period. The solar panel provided sufficient charging support, while the battery ensured uninterrupted operation for extended periods.

## VII. CONCLUSION

This project successfully demonstrated the design, development, and testing of the IoT Based Agri Bot Solar Tracker as an efficient, low-cost, and sustainable agricultural automation system. The developed prototype effectively integrates solar tracking technology, IoT-based monitoring, and automated farming operations to support smart agriculture with minimal human intervention.

The performance testing confirmed that the system could successfully monitor soil moisture, temperature, and humidity while enabling efficient seed sowing and field monitoring. The solar tracking mechanism improved energy utilization by continuously adjusting the solar panel toward sunlight, ensuring reliable operation without heavy dependence on external power sources. The integration of Wi-Fi communication and IoT platforms enabled real-time monitoring and remote accessibility, improving farming efficiency and decision-making.

The project validated that combining renewable energy, sensor technology, wireless communication, and automation can effectively reduce manual labor and improve agricultural productivity. The selected components, including solar panels, sensors, microcontrollers, motors, and battery systems,

demonstrated reliable performance during testing under normal operating conditions.

From an engineering perspective, this project highlights the importance of smart farming technologies in achieving sustainable agricultural development. The practical experience gained in hardware integration, sensor interfacing, programming, and IoT communication provided valuable exposure to real-world automation systems. Future improvements such as GPS navigation, AI-based crop monitoring, automated irrigation, and advanced sensing technologies can further enhance the system, making it more suitable for large-scale agricultural applications and commercialization.

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