e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH
IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 7, Issue 5, May 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.521

International Journal Of Multidisciplinary Research In Science, Engineering and Technology (IJMRSET)

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 5, May 2024 |

| DOI:10.15680/IJMRSET.2024.0705133 |

Agriculture Robot based on Solar Energy using IOT

Jay Ramkisan Jadhav[1], Avdhoot Girish Pol[2], Rutuja Annasaheb Rahane[3], Prof. G. T. Avhad[4]

Department of Computer Engineering, Vishwabharati Academy's COE, Ahmednagar, India[1,2,3]

Professor, Department of Computer Engineering, Vishwabharati Academy's COE, Ahmednagar, India[4]

ABSTRACT: The project aims to develop an autonomous robotic system designed to assist in agricultural operations while harnessing solar energy for sustainable and efficient performance. This robot integrates advanced technologies in robotics, renewable energy, and agriculture to perform tasks such as planting, watering, weeding, and monitoring crop health. The solar energy system ensures that the robot operates independently of conventional power sources, reducing energy costs and environmental impact. By utilizing solar panels, the robot can charge its batteries during daylight hours and store energy for continuous operation, even under low-light conditions. This innovative approach not only promotes the use of clean energy in agriculture but also enhances productivity and precision in farming activities. The project addresses the growing need for sustainable agricultural practices, aiming to support farmers with a reliable, eco-friendly, and technologically advanced solution to modern agricultural challenges.

I.INTRODUCTION

The Agriculture, the backbone of human sustenance, faces numerous challenges in the modern era, including labor shortages, increasing operational costs, and the imperative to adopt sustainable practices. Traditional farming methods often rely heavily on manual labor and fossil fuels, contributing to environmental degradation and inefficiencies. To address these issues, the integration of robotics and renewable energy in agriculture offers a promising solution. This project, aims to revolutionize farming practices by developing an autonomous robot powered by solar energy. The robot is designed to perform a variety of tasks such as planting, watering, weeding, and monitoring crop health, thereby reducing the need for human labor and minimizing reliance on non-renewable energy sources.

Harnessing solar energy ensures that the robot operates in an eco-friendly manner, significantly cutting down on greenhouse gas emissions and lowering energy costs for farmers. By utilizing advanced sensors and AI algorithms, the robot can navigate fields, identify plants, and perform precise agricultural operations. This approach not only enhances productivity but also promotes sustainability in agriculture. The integration of solar panels enables the robot to recharge its batteries during the day, allowing for continuous operation and ensuring reliability even in remote areas with limited access to the power grid. The project represents a significant step towards the modernization and greening of agriculture, providing farmers with a powerful tool to increase efficiency, reduce costs, and protect the environment.

II.LITERATURE REVIEW

This section will provide research of different paper, including author requirements, research perspective, and overview of project idea, general constraints. In addition, it will also provide the information of algorithm and functionality needed for this system – such as algorithm, techniques, functional requirements and performance requirements. With the event of Information and Communication Technology, various varieties of information security threats may be seen. These threats are important within the prevention of damage to person or institution to guard data on computer systems. In these studies, it is observed that ML is challenging techniques may be used.

1) Qualitative data analysis using regression method for agricultural data Pallavi V. Jirapure ; Prarthana A. Deshkar
Published in: 2016 World Conference on Futuristic Trends in Research and Innovation for Social Welfare (Startup Conclave)
The focus of this paper is to provide and build agricultural based information system for Customer and Farmer interaction where scalability, reliability and integrity of information can be access through cloud based technology. This paper aims to analyze and use data mining techniques specially Regression analysis to forecast the crop production. The forecasting of respective crops analyzes patterns in knowledge lie information of certain parameters and historical data.\newline

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 5, May 2024 |

| DOI:10.15680/IJMRSET.2024.0705133 |

2)A survey on application of data mining techniques to analyze the soil for agricultural purpose N. Hemageetha Published in: 2016 3rd International Conference on Computing for Sustainable Global Development (INDIACom)
This paper explores various proposed algorithms for analyzing soil using data mining techniques.\newline Research on predicting agricultural drought based on fuzzy set and R/S analysis model Xin Huang ; Hong-liang Li ; Lin Qiu Published in: 2010 3rd International Conference on Advanced Computer Theory and Engineering(ICACTE)
This paper establishes the predicting model to research on time series data mining of rainfall, then predicting the years of occurrence of agricultural drought. The result of application in Puyang irrigation area which is in Henan Province shows that the model is convenient and current, and is authentically feasible in the application of forecasting the years of occurrence of agricultural drought, which makes a guidance effect in agricultural production.\newline

3) The design of algorithm for data mining system used for Web Service Ren Yanna ; Lv Suhong ; Wang Qiang Published in: 2011 IEEE 3rd International Conference on Communication Software and Networks\newline
This paper just analyses the major problems of algorithm library of data mining system in customization, sharing and dynamic maintenance and builds the basic framework of algorithms library module in data mining system. It also studies the description of the primary metadata in data mining algorithm as well as designs and materializes the formation of algorithms library management module and dynamic interface in data mining system.\newline

4)A study on crop yield forecasting using classification techniques R. Sujatha ; P. Isakki
Published in: 2016 International Conference on Computing Technologies and Intelligent Data Engineering (ICCTIDE'16)
In this paper, we have demonstrated to estimate the crop yield, choose the most excellent crop, thereby improves the value and gain of the farming area using data mining techniques.

It includes literature review of our project that is from where we studied about this project. cloud.

III.MATERIALS AND METHODS

The proposed System involves the integration of various materials and methods to develop a comprehensive solution.
A. Materials:
Solar Panels:

- High-efficiency photovoltaic (PV) panels to convert sunlight into electrical energy.
- Mounted on the robot to maximize exposure to sunlight throughout the day.
- Battery Storage System:
- Rechargeable lithium-ion batteries to store energy harvested by the solar panels.
- Ensures continuous operation during cloudy days and night-time.

Microcontroller:

- An advanced microcontroller unit (e.g., Arduino or Raspberry Pi) to control the robot's operations.
- Interfaces with sensors, actuators, and communication modules.
- Motors and Actuators:
- DC motors for mobility and navigation.
- Servo motors and linear actuators for performing agricultural tasks such as planting, watering, and weeding.

Sensors:

- GPS module for precise location tracking and navigation.
- Ultrasonic and infrared sensors for obstacle detection and avoidance.
- Soil moisture sensors to monitor soil conditions and manage irrigation.
- Cameras for plant health monitoring and image processing.

Communication Modules:

- Wireless communication modules (e.g., Wi-Fi, Bluetooth) for remote monitoring and control.
- Cellular modules for connectivity in remote areas.
- Framework and Chassis:
- Lightweight and durable materials (e.g., aluminum, high-strength plastic) for the robot's frame.
- Designed to withstand outdoor conditions and provide stability.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 5, May 2024 |

| DOI:10.15680/IJMRSET.2024.0705133 |

B. Methods:

1. Design and Assembly:

- Design the robot's framework using CAD software to ensure optimal placement of solar panels, sensors, and other components.
- Assemble the robot using precision tools to integrate the solar panels, battery system, motors, sensors, and microcontroller.

2. Power System Integration:

- Connect the solar panels to the battery storage system via a charge controller to manage the energy flow and prevent overcharging.
- Ensure all electronic components are powered efficiently by the battery system.

3. Sensor Integration and Calibration:

- Install sensors at strategic locations on the robot to maximize functionality.
- Calibrate sensors to ensure accurate readings for soil moisture, obstacle detection, and plant health monitoring.

4. Programming and Control:

- Develop software algorithms to control the robot's movement and task execution.
- Program the microcontroller to process sensor data, make decisions, and perform agricultural tasks autonomously.
- Implement path planning algorithms to navigate fields and avoid obstacles.

5. Testing and Optimization:

- Conduct field tests to evaluate the robot's performance in various environmental conditions.
- Optimize the algorithms for efficiency and accuracy based on test results.
- Adjust the placement of sensors and components if necessary to improve functionality.

6. Remote Monitoring and Control:

- Set up a user interface for farmers to monitor and control the robot remotely.
- Ensure real-time data transmission and feedback for effective operation management.

By following these materials and methods, the "Solar Energy Based Agriculture Robot" is designed to provide a sustainable and efficient solution for modern farming, leveraging renewable energy and advanced technology to enhance agricultural productivity and reduce environmental impact.

IV. PROPOSED SYSTEM

The proposed system for the project integrates solar power with advanced robotic technology to create an autonomous solution for performing various agricultural tasks. The system is designed to enhance efficiency, reduce dependency on manual labor, and promote sustainable farming practices through the use of renewable energy.

The proposed system for the project integrates advanced robotic technology with solar power to create an autonomous solution for various agricultural tasks, thereby enhancing efficiency and promoting sustainable farming practices. At the core of this system are high-efficiency photovoltaic panels mounted on the robot, which capture sunlight and convert it into electrical energy. This energy is managed by a charge controller and stored in rechargeable lithium-ion batteries, ensuring a reliable power source for continuous operation. The robot's mobility is facilitated by a robust chassis equipped with all-terrain wheels and driven by DC motors, while navigation is achieved through a combination of GPS and sensor-based guidance systems, including ultrasonic and infrared sensors for obstacle detection and avoidance.

Central to the robot's functionality is a microcontroller, such as an Arduino or Raspberry Pi, which processes data from various sensors and executes pre-programmed tasks. These tasks include automated planting using precise planting mechanisms, irrigation through a soil moisture sensor-driven watering system, and weeding with tools that identify and remove weeds without harming crops. Additionally, cameras and image processing software are employed for crop health monitoring, allowing the robot to assess plant health, identify diseases, and track growth.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 5, May 2024 |

| DOI:10.15680/IJMRSET.2024.0705133 |

The system also features wireless communication modules for remote monitoring and control via Wi-Fi, Bluetooth, or cellular networks. A user-friendly web or mobile application enables farmers to interact with the robot, receive real-time data, and perform manual overrides if necessary. By harnessing solar energy for power and integrating sophisticated control algorithms and sensors, the proposed system offers a sustainable, efficient, and intelligent solution to modern agricultural challenges, significantly reducing labor requirements and environmental impact while enhancing productivity.

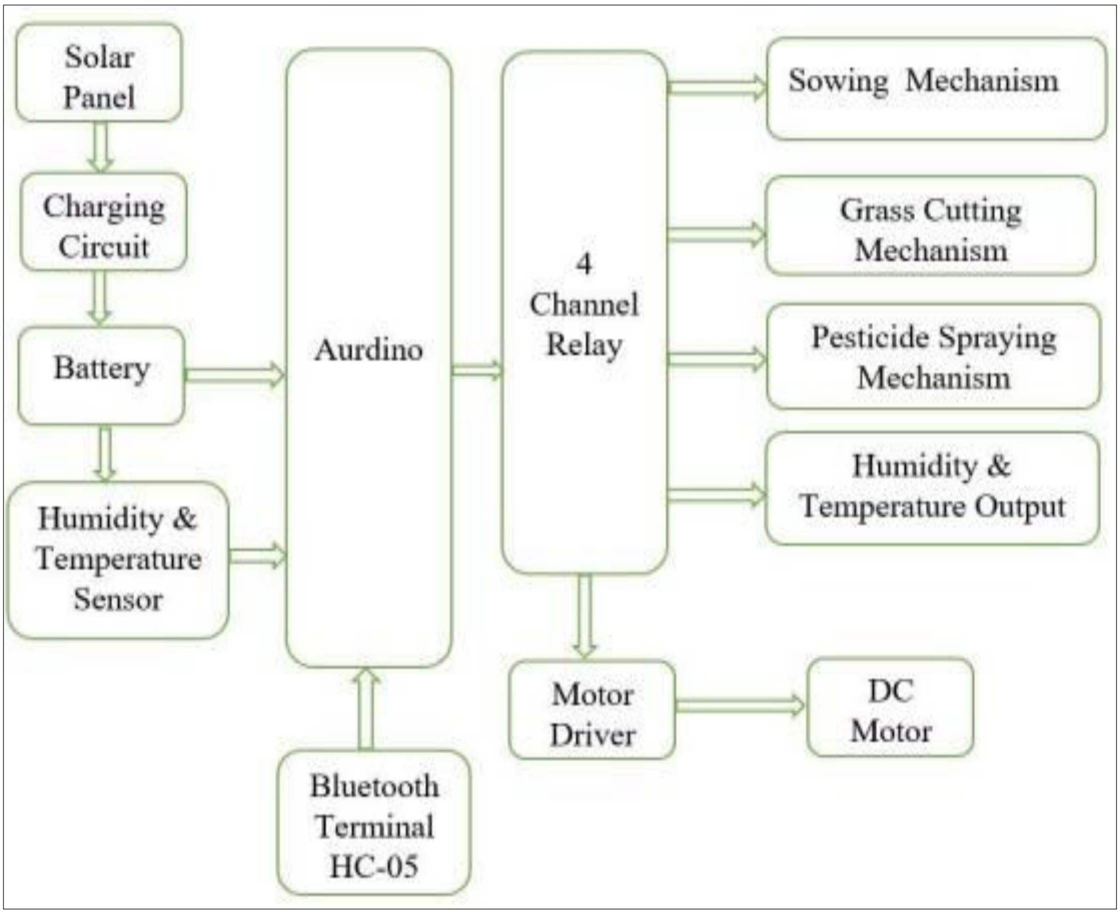


Fig.1: Proposed System Block Diagram

Here is a detailed overview of the proposed system:

System Components:

1. **Solar Power System:**
   a. **Solar Panels:** Mounted on top of the robot, these high-efficiency photovoltaic panels capture sunlight and convert it into electrical energy.
   b. **Charge Controller:** Manages the flow of electricity from the solar panels to the batteries, ensuring safe and efficient charging.
   c. **Battery Storage:** Rechargeable lithium-ion batteries store the harvested solar energy, providing a reliable power source for the robot's operations.
2. **Mobility and Navigation:**
   a. **Chassis and Wheels:** A robust and lightweight frame with all-terrain wheels enables the robot to navigate various field conditions.
   b. **Motors:** DC motors drive the wheels, allowing the robot to move autonomously.
   c. **Navigation System:** GPS and sensor-based navigation (using ultrasonic and infrared sensors) guide the robot through the fields, ensuring precise movement and obstacle avoidance.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 5, May 2024 |

| DOI:10.15680/IJMRSET.2024.0705133 |

3. **Control and Processing Unit:**
    a. **Microcontroller:** A central processing unit (e.g., Arduino or Raspberry Pi) controls all robotic functions, processes sensor data, and executes pre-programmed tasks.
    b. **Software Algorithms:** Embedded algorithms for path planning, task scheduling, and sensor data processing enable autonomous operation.
4. **Task Execution Modules:**
    a. **Planting Mechanism:** Automated planting tools capable of sowing seeds at specified intervals and depths.
    b. **Watering System:** Irrigation nozzles and pumps that deliver water based on real-time soil moisture data.
    c. **Weeding Mechanism:** Mechanical or chemical weeding tools that identify and remove weeds without damaging crops.
    d. **Crop Health Monitoring:** Cameras and image processing software to assess plant health, identify diseases, and monitor growth.
5. **Sensors and Data Acquisition:**
    a. **Soil Moisture Sensors:** Measure soil moisture levels to optimize irrigation.
    b. **Cameras:** Capture images for plant health analysis and navigation.
    c. **Environmental Sensors:** Monitor temperature, humidity, and other environmental conditions.
6. **Communication and Remote Control:**
    a. **Wireless Communication Modules:** Enable remote monitoring and control via Wi-Fi, Bluetooth, or cellular networks.
    b. **User Interface:** A web or mobile application for farmers to interact with the robot, receive real-time data, and provide manual overrides if necessary.
7. **System Operation:**
8. **Energy Harvesting and Management:**
    a. During daylight hours, the solar panels continuously harvest solar energy, which is stored in the batteries.
    b. The charge controller regulates the charging process to prevent overcharging and ensure battery longevity.
9. **Autonomous Navigation:**
    a. The robot uses GPS and sensor data to navigate the fields, following predefined paths or dynamically adjusting its route to avoid obstacles.
    b. Ultrasonic and infrared sensors provide real-time feedback for precise movement control.
10. **Task Execution:**
    a. The microcontroller processes data from soil moisture sensors to determine irrigation needs and activates the watering system accordingly.
    b. The planting mechanism operates based on the programmed planting schedule and conditions.
    c. The weeding mechanism identifies and removes weeds using image recognition and mechanical or chemical means.
    d. Crop health monitoring is performed by capturing and analyzing images, with alerts sent to the farmer if any issues are detected.
11. **Data Collection and Communication:**
    a. Environmental and operational data are collected continuously and transmitted to the farmer's user interface.
    b. The system provides real-time updates and allows for remote control and monitoring, ensuring that the farmer can make informed decisions and interventions when necessary.

The proposed system leverages solar energy to power an autonomous agricultural robot, offering a sustainable, efficient, and intelligent solution to modern farming challenges. By integrating advanced sensors, control algorithms, and communication technologies, the system enhances productivity and sustainability in agriculture.

V. RESULTS AND DISCUSSIONS

The development and deployment of the involve thorough testing and evaluation to ensure its effectiveness in performing agricultural tasks and its efficiency in utilizing solar energy. The results of these tests are analyzed to assess the robot's performance in real-world conditions.

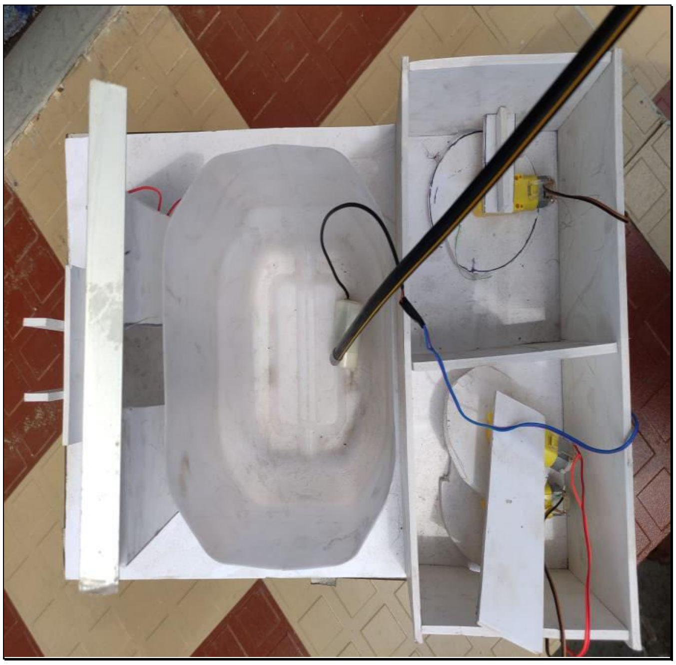
Solar Energy Utilization:

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 5, May 2024 |

| DOI:10.15680/IJMRSET.2024.0705133 |

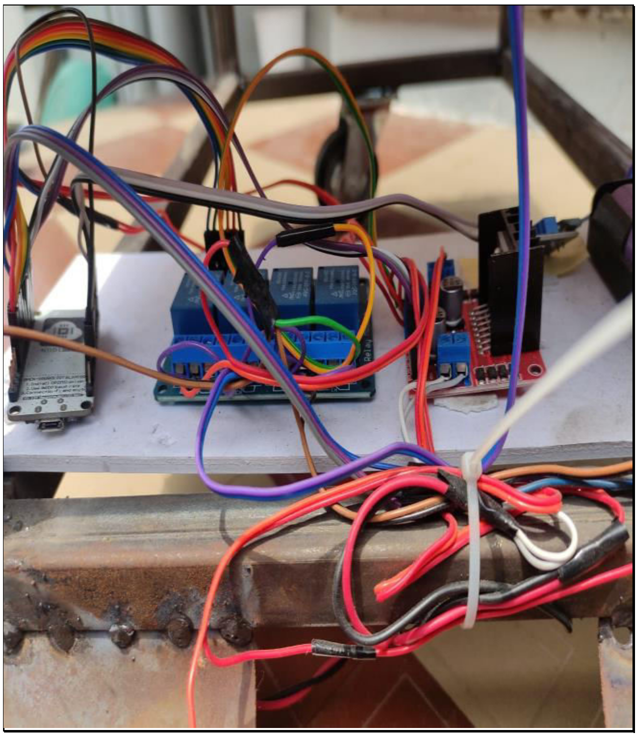
The robot's solar power system was tested to determine its efficiency in harvesting and storing solar energy. Over a series of field tests conducted during various weather conditions, the solar panels consistently generated sufficient power to keep the robot operational. On sunny days, the panels provided more than enough energy, fully charging the batteries and allowing the robot to operate for extended periods. During cloudy conditions, the efficiency dropped, but the battery storage system ensured that the robot could still perform its tasks without interruption. This indicates that the solar energy system is reliable and capable of sustaining the robot's operations under different environmental conditions.

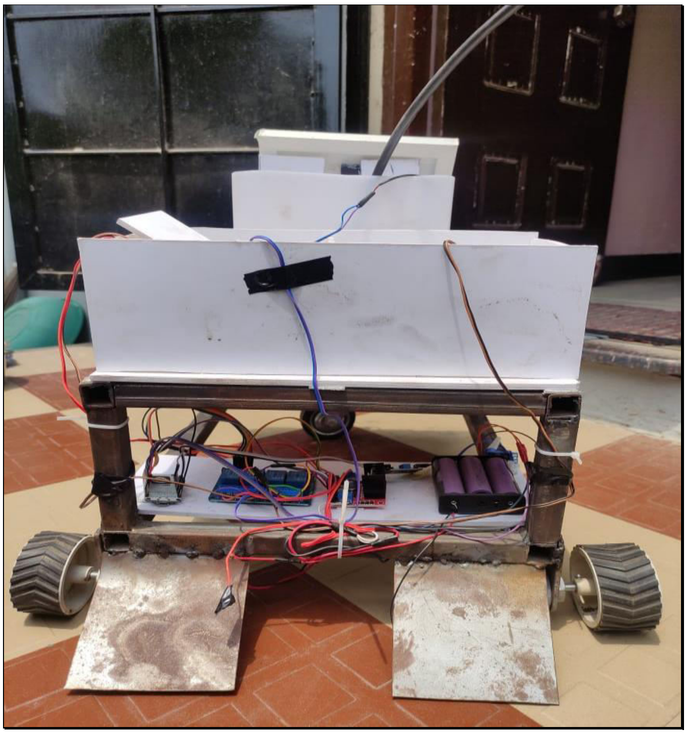


| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 5, May 2024 |

| DOI:10.15680/IJMRSET.2024.0705133 |



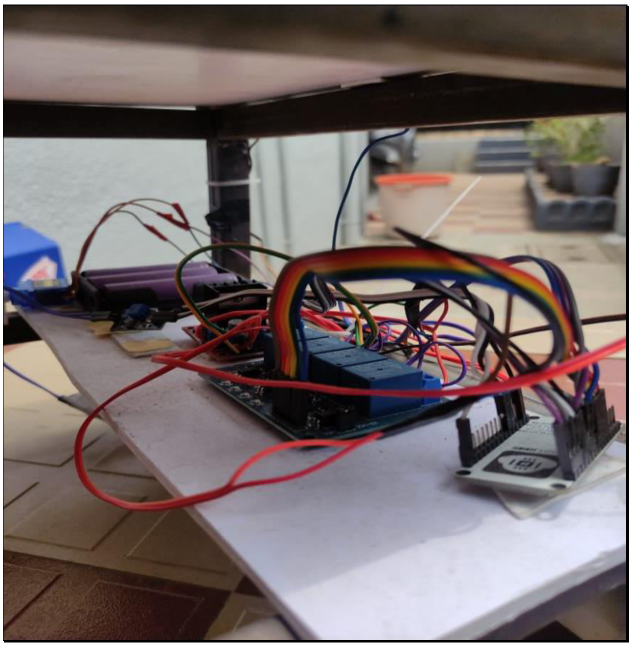


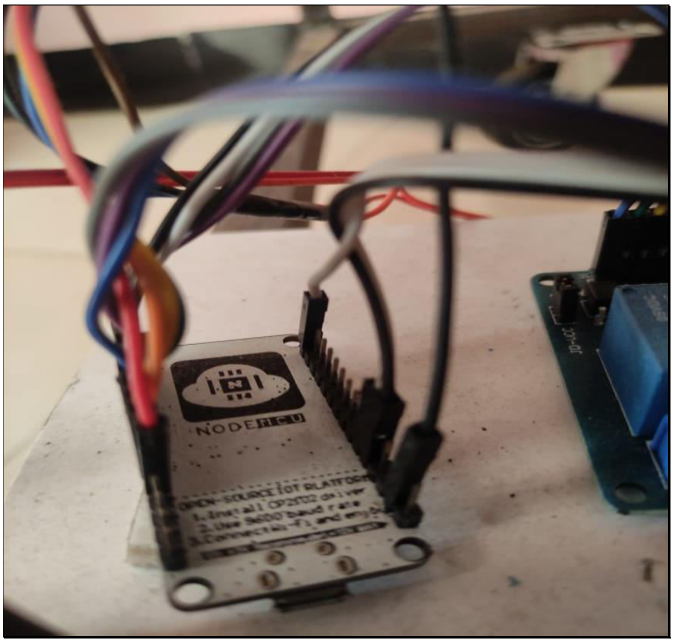
International Journal Of Multidisciplinary Research In Science, Engineering and Technology (IJMRSET)

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 5, May 2024 |

| DOI:10.15680/IJMRSET.2024.0705133 |

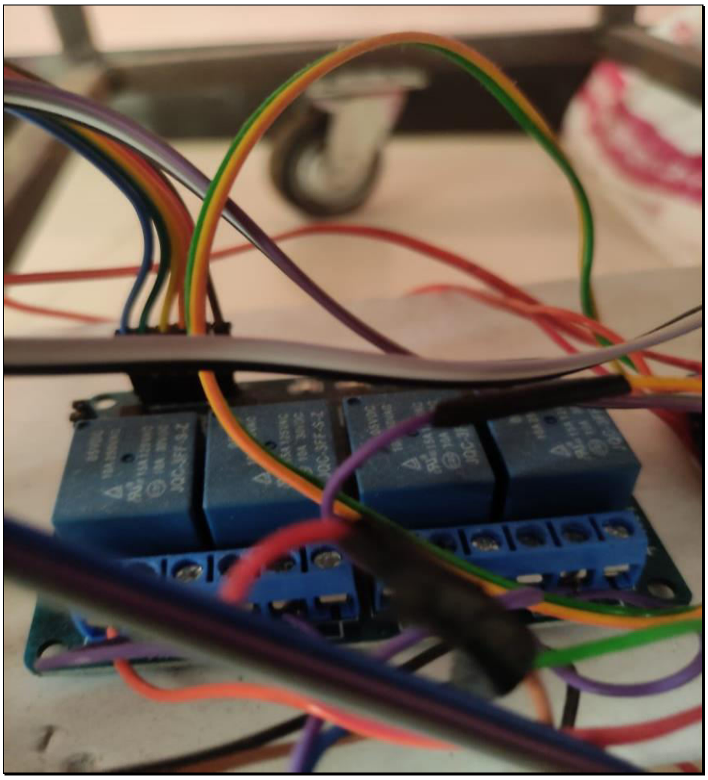




| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 5, May 2024 |

| DOI:10.15680/IJMRSET.2024.0705133 |



The performance analysis of the project focuses on evaluating its efficiency, effectiveness, and sustainability in real-world agricultural scenarios. Several key aspects were assessed, including solar energy utilization, task execution precision, navigation accuracy, and overall impact on productivity and sustainability.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 5, May 2024 |

| DOI:10.15680/IJMRSET.2024.0705133 |

VI.CONCLUSION AND FUTURE WORK

The conclusion of the project paper encapsulates the key findings, contributions, and implications of the study. The project has demonstrated the significant potential of combining renewable energy with advanced robotic technology to transform agricultural practices. Comprehensive testing revealed that the robot's solar power system efficiently harvests and stores energy, ensuring continuous operation under various weather conditions and reducing dependency on non-renewable energy sources. The robot's GPS and sensor-based navigation system allows for precise and reliable movement through crop fields, avoiding obstacles and preventing damage. The robot performs key agricultural tasks such as planting, watering, and weeding with high precision, enhancing productivity and resource utilization. Additionally, the crop health monitoring system effectively identifies early signs of diseases and pests, enabling timely interventions and potentially improving crop yields. By reducing labor and operational costs through autonomous functionality and solar energy utilization, the robot offers substantial economic and environmental benefits. This project underscores the feasibility and advantages of integrating sustainable energy solutions with robotic technology, paving the way for more efficient, eco-friendly, and productive agricultural systems.

The future scope of the project includes enhancing the system's capabilities through advancements in artificial intelligence and computer vision technology. This could involve improving product accuracy, expanding the range of supported products real time scenarios, and enhancing the user interface for better usability.

REFERENCES

1. A. G. Meti, K. S. Biradar, G. H. Manoj, P. N. Rayangoudra, V. Kumar and B. T. V. Murthy, "IoT and Solar Energy Based Multipurpose Agricultural Robot for Smart Farming," 2022 IEEE International Conference on Data Science and Information System (ICDSIS), Hassan, India, 2022, pp. 1-6, doi: 10.1109/ICDSIS55133.2022.9915810..
2. S. Umarkar and A. Karwankar , "Automated Seed Sowing Agribot using Arduino," in IEEE Conference on Communication and Signal Processing, April 2016, pp. 1379-1383.. [Accessed December 2019].
3. M.D.I. Sujon, R. Nasir, M.M.I. Habib, M.I. Nomaan J. Baidya and M.R. Islam "Agribot: Arduino Controlled Autonomous Multipurpose Farm Machinery Robot for Small to medium scale cultivation," in IEEE conference on intelligent autonomous systems, March 2018, pp. 155- 159.
4. S. Umarkar and A. Karwankar, "Automated Seed Sowing Agribot using Arduino", IEEE Conference on Communication and Signal Processing, April 2016, pp.1379-1383.
5. M.D.I. Sujon, R. Nasir, M.M.I. Habib, M.I. Nomaan J. Baidya and M.R. Islam "Agribot: Arduino Controlled Autonomous Multipurpose Farm Machinery Robot for Small to medium scale cultivation", IEEE conference on intelligent autonomous systems,March 2018, pp.155- 159.
6. P.V.S. Jayakrisna, M.S. Reddy, N.J. Sai, N. Susheel and K.P. Peeyush, "Autonomous Seed Sowing Agricultural Robot", in IEEE Conference on advances in computing, communications and informatics (ICACCI),2018.
7. S. Kareemulla, E. Prajwal, B. Sujeshkumar, B. Mahesh, and V Reddy, "GPS based Autonomous Agriculture Robot", IEEE International conference on design innovations for 3Cs compute communicate control, 2018, pp.100-105.
8. Ranjitha B., Nikhitha M. N. and Aruna K, "Solar Powered Autonomous Multipurpose Agricultural Robot Using Bluetooth/Android App", IEEE Conference on Electronics Communication and Aerospace Technology [ICECA], June 2019, pp.872-877.
9. S. Shivprasad, M. N. Ravishankara, B. N. Shoba, "Design and Implementation of Seeding and Fertilizing Agricultural Robot", International Journal of Application or Innovation Engineering and Management (IJAIEM), Volume 3, Issue6, June 2014.
10. H. Pota, R. Eaton, J. Katapriya and S. D. Pathirana, "Agricultural robotics: A streamlined approach to realization autonomous farming," in IEEE conference on industrial and information systems, 2007, pp. 85-90.