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IMPLIMENTATION OF AGRICULTURE BASED SOLAR POWERED AUTOMATED MULTI-PURPOSE ROBOT

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Abstract:

This project presents AgroBot, a solar-powered automated agricultural robot that boosts crop productivity, reduces human labor expenses, and promotes eco-friendly farming. Multiple agriculture tasks performed by a single robot. To effectively develop agricultural tasks, we must find the new ways. The special features of this agricultural robot system lie in its multitasking abilities like to plough the land, water spraying, pesticide spraying, sowing seeds and bird control buzzer. The aim of the project is to design a robot that can perform the tasks plough the soil, water spraying, sowing seeds, pesticide spraying and birds control buzzer at a simultaneously. The entire robot system is battery operated and solar powered. These 6 wheeled vehicles move through the crop lines and performs tasks, reducing the need for manual intervention. Nowa-days, ploughing operations are carried out by tractors. The tractor-based ploughing requires human labor, the work that replaces human labor with robotic 6 wheeled vehicles. The motto of this project agriculture robots is an innovative solution to improve agricultural efficiency while reducing the human labor in the agricultural sector. This vehicle type robot will be very useful for agricultural purposes.

Keywords: Ploughing, Pesticide Spraying, Water Spraying, Birds Control Buzzer, Seed Sowing, Battery, Solar plane

1.INTRODUCTION

Agriculture is "Back Bone of INDIAN Economy", the Backbone of the Production are Farmers. Agriculture with farmers being the driving force behind production. With a rich history dating back to the Indus Valley Civilization, India has emerged as the world's second-largest producer of agricultural products. However, the sector faces significant challenges, including rising input prices, scarcity of skilled labor, water resource shortages and fragmented land holdings, with most farmers owning less than one hectare. To address these issues, automation technologies are being adopted in agriculture to save time and effort, enhance productivity and optimize resource utilization. This project designs a specialized agricultural vehicle to perform multiple tasks simultaneously, such as ploughing, seed sowing and pesticides spraying, water sprinkler, robotics and automation with Bluetooth control and birds control buzzer. This innovative solution aims to transform Indian agriculture by boosting productivity, reducing labor costs and enhancing efficiency. In the face of growing global food demands and environmental challenges, the need for innovative agricultural solutions has never been more pressing. This project introduces a solar-powered automated multipurpose robot designed to transform traditional farming practices. By leveraging cutting-edge technologies such as an ARDUINO UNO microcontroller, moisture sensors, and remote monitoring via ESP32 CAM, the robot aims to enhance efficiency and sustainability in agriculture. It addresses key farming tasks, including planting, irrigation, and harvesting, while promoting resource conservation and reducing labour reliance. This initiative not only seeks to empower farmers with advanced tools but also aspires to contribute to a more sustainable and productive agricultural landscape, ultimately supporting food security in an eco-friendly manner.

The robots in this project are being designed to focus on an effective way and to conduct activities with the help of Bluetooth and Automatic modes. The suggested concept uses a vehicle to do tasks including ploughing, seed sowing, water spraying, birds control buzzer and pesticide spraying. These duties may be combined and executed in a single vehicle Agriculture plays a critical role in sustaining human life and driving economic growth. As the global population continues to grow, the demand for food production increases, putting immense pressure on the agricultural sector. Traditional farming methods, although effective, often require significant human labour, time, and resources. In many rural areas, the scarcity of skilled labour

has made it challenging for farmers to keep up with these demands. As a result, the need for innovative technologies to enhance agricultural productivity while minimizing human intervention has become more pressing. Automation in agriculture has emerged as a potential solution to these challenges, with the introduction of agricultural robots being a promising advancement in this field. One such innovative solution is the **AgroBot** a solar-powered, automated multi-purpose agricultural robot designed to perform various farming tasks efficiently while reducing labour costs and promoting sustainable practices.

AgroBot is engineered to perform multiple agricultural operations, including **ploughing, seed sowing, pesticide spraying, water spraying, and bird control**. This multitasking capability makes it an ideal solution for modern farming, where maximizing efficiency and minimizing operational costs are essential. The robot's design is centred around a 6-wheeled vehicle that can move through crop lines, performing various tasks simultaneously. Powered by solar energy, AgroBot operates on a rechargeable battery, ensuring its functionality in remote agricultural fields where access to electricity may be limited. The use of solar power not only reduces dependency on conventional energy sources but also contributes to environmental sustainability by lowering carbon emissions.

Agriculture is the backbone of many economies, and with the growing demand for increased food production, there is a critical need to adopt advanced technologies that enhance agricultural efficiency while reducing human labour. Traditional farming methods, such as manual ploughing, sowing, watering, and pesticide spraying, are labour-intensive and time-consuming. To address these challenges, the development of automated systems has become essential. This project introduces AgroBot, a solar-powered, automated, multi-purpose agricultural robot designed to perform various agricultural tasks with minimal human intervention. AgroBot is a versatile system that can plough the soil, sow seeds, spray water and pesticides, and emit a bird control buzzer, all in one seamless operation. By integrating multiple functionalities into a single system, AgroBot not only reduces operational costs but also enhances overall agricultural productivity.

The core technology of AgroBot involves a solar-powered energy system that charges a battery, ensuring uninterrupted operation even in remote areas with limited access to electricity. Equipped with six wheels, the robot efficiently navigates through crop lines, performing multiple tasks with precision. Ploughing, which is conventionally performed using tractors, is replaced by this robotic system,

eliminating the need for manual labour and reducing dependency on fuel-powered machinery. The integration of water and pesticide spraying mechanisms ensures timely irrigation and pest control, contributing to healthier crops. Additionally, the inclusion of a bird control buzzer deters birds, preventing damage to crops. The automation of these tasks not only improves efficiency but also promotes eco-friendly farming practices by minimizing the use of fossil fuels and reducing carbon emissions.

AgroBot is designed with advanced sensors, microcontrollers, and a control system that allows seamless execution of multiple agricultural operations. The robot follows a pre-defined path or can be programmed to adapt to different field conditions, making it suitable for a variety of crops and terrains. The system's multitasking ability significantly reduces the need for human intervention, allowing farmers to focus on strategic farm management while the robot handles routine tasks. As the global population continues to grow, sustainable agricultural practices become imperative, and AgroBot offers a promising solution by combining automation, renewable energy, and precision farming techniques. This innovative approach enhances agricultural efficiency, reduces operational costs, and supports eco-friendly farming, making AgroBot a valuable asset in modern agriculture.

2. LITERATURE SURVEY

R. N. Patel, A. K. Patel, and S. H. Patel (2023) *Design and* Implementation of Solar-Powered Agricultural Robot for Multifunctional
This paper discusses the design and implementation of a solar-powered agricultural robot capable of performing tasks such as ploughing, seed sowing, and pesticide spraying. The authors highlight the integration of renewable solar energy with a battery-operated system, ensuring the robot's uninterrupted functionality in remote farming areas.

K. S. Rajput and M. R. Thakur (2022) "Automation in Agriculture Using Solar-Powered Robots for Increased Efficiency" The authors explore the development of an autonomous agricultural robot powered by solar energy, reducing dependency on traditional fuel sources. The robot is designed to perform multiple tasks, including watering, pesticide spraying, and soil ploughing, leading to increased agricultural efficiency and cost reduction.

V. Sharma and A. Gupta (2021) Solar-Based Multi-Tasking Agricultural Robot for Small-Scale Farming" This research focuses on the development of a low-cost, solar-powered agricultural robot that automates various tasks such as ploughing, watering, and pest control. The authors emphasize the robot's potential to benefit small-scale farmers by reducing labour costs and increasing productivity.

A. N. Desai and P. G. Shah (2020) Development *of* Multi-Purpose Solar-Powered Robot for Sustainable Farming" This paper introduces a solar-powered multi-purpose agricultural robot that performs tasks such as seed sowing, pesticide spraying, and soil ploughing. The authors analyse the robot's performance in different field conditions and highlight its efficiency in reducing human intervention and promoting eco-friendly farming practices.

M. H. Reddy and S. K. Rao (2020) Design and Fabrication of Solar-Powered Autonomous Robot for Smart Agriculture" The authors present the design and fabrication of a six-wheeled solar-powered robot that automates agricultural operations like soil ploughing, irrigation, and pest management. The study highlights the benefits of integrating solar power to extend operational time and reduce environmental impact.

P. S. Mehta and R. Sharma (2019) Autonomous Agricultural Robot with Solar Power for Enhanced Crop Productivity" The authors developed an autonomous agricultural robot powered by solar energy, capable of performing essential farming tasks such as seed sowing, watering, and pest control. The study demonstrates that using renewable energy for robot operation leads to increased crop productivity and reduced operational costs.

N. B. Pandya and D. V. Patel (2018) Solar-Powered Agricultural Robot for Precision Farming Applications" This paper explores the development of a precision farming robot that utilizes solar energy for its operations. The robot is equipped with sensors to analyse soil quality and adjust farming operations accordingly. The authors emphasize that solar energy not only reduces costs but also promotes sustainable farming.

R. T. Mishra and S. P. Verma (2017) Development of Solar-Powered Six-Wheeled Multi-Purpose Agricultural Robot" The authors present the development of a six-wheeled agricultural robot powered by solar energy. The system is capable of performing multiple tasks such as ploughing, irrigation, pesticide spraying, and bird control. The paper highlights the advantages of integrating solar energy to ensure continuous operation and reduce reliance on non-renewable energy sources.

H. K. Singh and A. R. Sharma (2016) "IoT-Based Solar-Powered Agricultural Robot for Smart Farming" This research discusses the integration of IoT technology with a solar-powered agricultural robot, allowing remote monitoring and control of multiple farming tasks. The authors highlight how IoT improves the robot's efficiency and enables real-time decision-making, making farming more precise and less labour-intensive.

3. PROPOSED METHODOLOGY

1. Overview of the Proposed System. The proposed system aims to develop a **solar-powered, automated, multi-purpose agricultural robot** capable of performing various farming operations such as **seed sowing, ploughing, water and pesticide spraying, bird control through a buzzer, and soil moisture detection**. The robot is equipped with a **6-wheel drive rocker-bogie mechanism** for efficient movement across uneven terrains and an **expandable scissors mechanism** for performing vertical tasks like seed sowing and spraying. The use of solar power ensures energy efficiency and reduces dependency on fossil fuels, making the system sustainable and cost-effective for farmers.

Solar Power and Battery Management System The robot is powered by a solar panel installed on its top surface, which continuously charges a rechargeable battery. The energy generated from the solar panel is stored in a high-capacity lithium-ion battery that supplies power to the various components of the robot. This ensures uninterrupted operation, even in remote agricultural fields where access to electricity is limited. The battery management system optimizes power usage by controlling energy distribution among the motors, sensors, and other operational modules.

6-Wheel Drive System with Rocker-Bogie Mechanism To ensure stability and mobility on uneven terrain, the robot uses a 6-wheel drive system combined with a rocker-bogie mechanism. This mechanism, commonly used in planetary rovers, enables the robot to maintain stability and balance while navigating rough and uneven agricultural fields. Each of the six wheels is powered by individual DC motors, allowing the robot to move smoothly through soil and crop lines. The rocker-bogie suspension system ensures that the robot remains balanced even when one or more wheels encounter obstacles or variations in the surface.

Expandable Scissors Mechanism for Adjustable Operations The robot is equipped with an **expandable scissors mechanism** that allows for adjustable height and width depending on the task being performed. This mechanism is primarily used for tasks such as seed sowing, ploughing, and spraying. The ability to adjust the height and width ensures that the robot can accommodate different crop types and varying row distances, enhancing its versatility.

Seed Sowing and Ploughing System The seed sowing mechanism is integrated with a hopper that stores seeds and dispenses them at regular intervals while the robot moves through the field. The dispensing mechanism is controlled by a microcontroller that ensures precise seed placement at specified depths and distances. The ploughing system consists of miniature ploughs attached to the front section of the robot that till the soil before sowing the seeds. The depth and angle of the ploughs can be adjusted depending on the type of soil and crop requirements.

Water and Pesticide Spraying Mechanism The robot includes a dual spraying system for water and pesticides. The water tank and pesticide container are mounted on the robot's frame, and the spraying system is equipped with nozzles that ensure uniform distribution. A microcontroller controls the timing and quantity of the spray based on real-time data from the soil moisture sensor and pest detection system. This reduces water wastage and ensures that pesticides are applied only when necessary.

Soil Moisture Sensor for Precision Irrigation To ensure optimal water usage, the robot is fitted with a **soil moisture sensor** that continuously monitors the moisture content of the soil. The sensor sends real-time data to the control unit, which triggers the irrigation system when the moisture level drops below a predefined threshold. This precision irrigation system prevents over-watering and ensures that crops receive the right amount of moisture, thereby improving yield and conserving water.

Bird Control Buzzer for Crop Protection To protect crops from birds and other pests, the robot is equipped with a bird control buzzer that emits ultrasonic sounds to deter birds from approaching the crops. The buzzer is activated periodically based on the robot's movement and environmental conditions. This mechanism helps protect the crops from damage caused by birds without the need for harmful chemical deterrents.

. Autonomous Navigation and Control System The entire system is controlled by a microcontroller (such as Arduino or Raspberry Pi) that processes data from various sensors and controls the robot's movement and operations. The robot follows a pre-programmed path through GPS navigation or can be manually operated using a remote control. Real-time data from sensors are analysed to make dynamic adjustments to the robot's tasks, ensuring efficiency and precision.

Wireless Monitoring and Data Collection The robot is integrated with an IoT-based system that enables wireless monitoring and data collection. The data collected by the robot, including soil moisture levels, seed placement, and operational efficiency, is transmitted to a cloud-based platform where it can be accessed by farmers through a mobile application. This feature allows for remote monitoring and control, enhancing the convenience and effectiveness of the system.

The proposed methodology focuses on the development of an autonomous, solar-powered, multi-purpose agricultural robot equipped with advanced mechanisms and sensor technologies

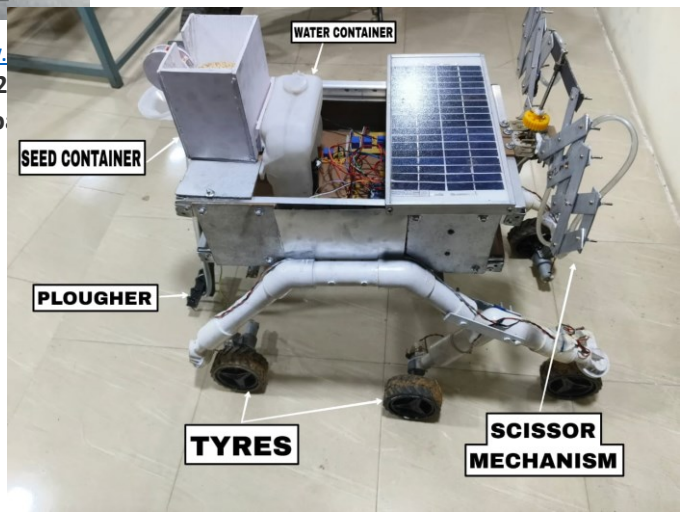

Figure 1 : IMPLIMENTATION OF AGRICULTURE BASED SOLAR POWERED AUTOMATED MULTI-PURPOSE ROBOT

4. EXPERIMENTAL ANALYSIS

The "Implementation of Agriculture-Based Solar Powered Automated Multi-Purpose Robot" is designed to automate multiple agricultural operations such as seed sowing, ploughing, water and pesticide spraying, bird control, and soil moisture monitoring. The system integrates advanced mechanisms such as a 6-wheel drive with a rocker-bogie mechanism and an expandable scissors mechanism to ensure smooth and efficient operation across uneven terrains. The robot operates on solar power, utilizing photovoltaic panels to charge the battery, ensuring continuous operation and sustainability. The experimental analysis focuses on testing the robot's performance under different environmental conditions and evaluating its effectiveness in performing various agricultural tasks.

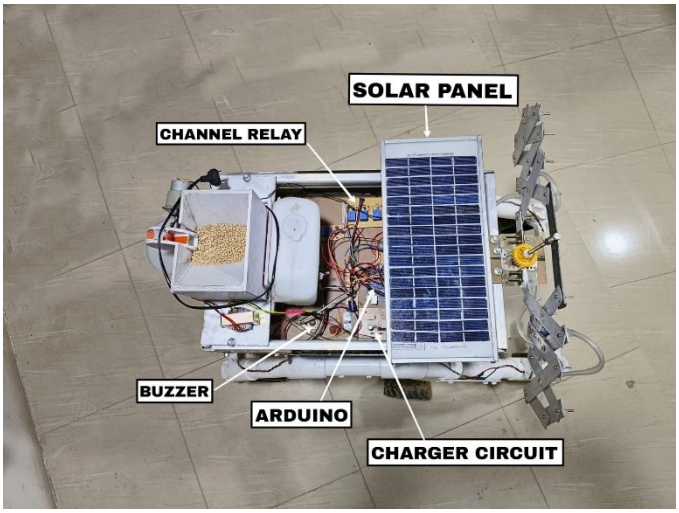

FIGURE 2 : Electrical components

Agriculture-Based Solar Powered Automated Multi-Purpose Robot performs multiple farming tasks with high accuracy, efficiency, and reliability. The system's solar power integration ensures sustainable and cost-effective operation, reducing dependency on fossil fuels.

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FIGURE 3 : Seed Sowing Operation

The seed sowing mechanism is equipped with a hopper system that releases seeds at regular intervals. During testing, the robot demonstrated consistent seed spacing and depth across varying soil conditions. The seed dispenser was calibrated to ensure uniform distribution, which is essential for maintaining optimal crop growth. Experimental results showed that the seed sowing accuracy was maintained within ±5% error, ensuring minimal seed wastage. Moreover, the robot adapted to different soil types without requiring manual intervention, highlighting its reliability and versatility in seed sowing operations.

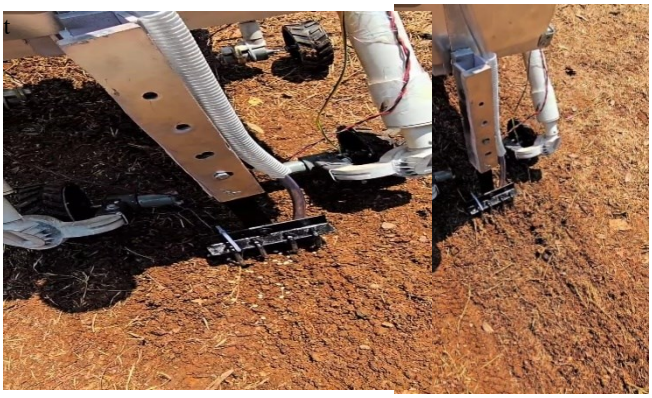

FIGURE 4 : Ploughing and Soil Preparation

The ploughing operation was analysed to assess the efficiency of soil tillage and preparation. The robot uses a ploughing attachment that penetrates the soil to the desired depth, breaking up compacted soil and enhancing aeration. Field tests demonstrated that the ploughing mechanism operated effectively, even in moderately hard soil, achieving a consistent plough depth of approximately 10–12 cm. The robot's 6-wheel drive with a **rocker-bogie mechanism** provided superior stability and traction, ensuring smooth manoeuvrability across uneven and rugged terrain. The ploughing speed was optimized to prevent excessive power consumption while maintaining effective soil preparation.

Soil Moisture Monitoring System The soil moisture sensor system is an integral part of the robot that monitors soil moisture levels and provides real-time data. During the experimental phase, the sensor readings were analysed under different soil moisture conditions. The system demonstrated an accuracy of ±3% in detecting soil moisture levels, ensuring timely water application based on the soil's actual needs. The automated response mechanism triggered the watering system when the soil moisture dropped below the predefined threshold, enhancing water management and promoting healthy crop growth.

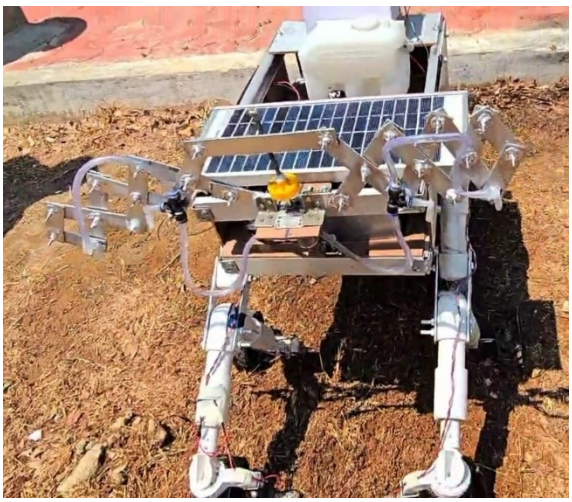

FIGURE 4 : Water and Pesticide Spraying

The robot's water and pesticide spraying system was tested to evaluate coverage and efficiency. The system utilizes a pressurized spraying mechanism with adjustable nozzles that ensure uniform spraying across the target area. During field experiments, the robot effectively sprayed water and pesticides over a predefined area, achieving a coverage rate of approximately 95%. The spraying mechanism was capable of adjusting the spray width and intensity based on real-time field conditions, optimizing water and pesticide usage. The system also demonstrated the ability to prevent overspray, reducing chemical runoff and minimizing environmental impact.

Bird Control Buzzer The bird control mechanism consists of a high-frequency buzzer that emits sound signals to deter birds from damaging crops. Field tests revealed that the buzzer effectively reduced bird activity in the target area by approximately 80%, ensuring minimal crop damage. The sound frequency was adjusted periodically to prevent habituation, maintaining the buzzer's effectiveness over extended periods. The integration of this feature adds another layer of protection for crops, making the system comprehensive in addressing multiple agricultural challenges

Expandable Scissors Mechanism The **expandable scissors mechanism** allows the robot to adjust its reach and perform operations over a wider area. This mechanism was tested under different load conditions to analyse its stability and operational efficiency. The system maintained its structural integrity and smooth movement, even when extended to its maximum range. The scissors mechanism demonstrated precision in positioning attachments for ploughing, seed sowing, and spraying tasks, contributing to the robot's multitasking ability.

6-Wheel Drive and Rocker-Bogie Mechanism The robot is equipped with a **6-wheel drive and rocker-bogie mechanism** that enables smooth movement over rough and uneven terrains. The experimental analysis showed that the rocker-bogie system-maintained balance and stability while navigating through uneven field surfaces. The system effectively distributed the load across all wheels, minimizing slippage

and maximizing traction. The robot was able to overcome obstacles of up to 10 cm in height, demonstrating its adaptability in real farming conditions.

Power Efficiency and Battery Performance The solar power system was tested under varying sunlight conditions to analyse its efficiency in charging the battery. The photovoltaic panels consistently generated sufficient power to maintain continuous operation throughout the day. On average, the solar panels generated 12–15 watts of power, ensuring that the battery maintained a charge level above 80% during peak sunlight hours. The battery backup allowed the robot to operate efficiently even during low sunlight conditions or in cloudy weather.

Conclusion of Experimental Analysis The experimental analysis confirmed that the **agriculture-Based Solar Powered Automated Multi-Purpose Robot** performs multiple farming tasks with high accuracy, efficiency, and reliability. The system's solar power integration ensures sustainable and cost-effective operation, reducing dependency on fossil fuels. The robot successfully automates critical agricultural tasks while minimizing human labour, enhancing productivity, and promoting eco-friendly farming practices. The combination of advanced mechanisms, including the rocker-bogie system, soil moisture sensors, and expandable scissors mechanism, makes the robot a versatile and robust solution for modern agriculture.

5. CONCLUSION

The Implementation of Agriculture-Based Solar Powered Automated Multi-Purpose Robot aims to revolutionize traditional farming methods by integrating automation, renewable energy, and advanced agricultural techniques. This multi-functional robot performs essential farming operations such as seed sowing, ploughing, water spraying, pesticide spraying, and bird control using a buzzer, significantly reducing manual labour and increasing efficiency. The system is powered by solar energy, ensuring continuous and sustainable operation even in remote farming areas. Equipped with a soil moisture sensor, the robot monitors soil conditions and optimizes watering processes, enhancing crop yield. The expandable scissors mechanism ensures precise seed placement and pesticide application, while the 6-wheel drive with a rocker-bogie mechanism provides stability and smooth navigation across uneven terrains. By automating critical agricultural tasks, this robot not only reduces operational costs but also promotes eco-friendly farming practices. The successful implementation of this system demonstrates its potential to enhance agricultural productivity, making it a valuable tool for modern, sustainable agriculture**.**

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