Solar Agro-Tech Rover

Keshav Negalur[1]
Electrical and Electronics Engineering Deprtment
SKSVMACET,
Lakshmeshwar
VTU, Belagavi
keshrash@gmail.com

Haripriya[2]
Electrical and Electronics Engineering Deprtment
SKSVMACET,
Lakshmeshwar
VTU, Belagavi
haripriyapatwari@gmail.com

Manu Pawar[3]
Electrical and Electronics Engineering Deprtment
SKSVMACET,
Lakshmeshwar
VTU, Belagavi
manusripawar213@gmail.com

Akshay V Bheemaradder[4]
Electrical and Electronics Engineering Deprtment
SKSVMACET,
Lakshmeshwar
VTU, Belagavi
akshaybm124@gmail.com

Mallikarjunayya Bhixavatihiremath[5]
Electrical and Electronics Engineering Deprtment
SKSVMACET,
Lakshmeshwar
VTU, Belagavi
mallikarjunayyahiremath2610@gmail.com

Shivalingappa D R[6]
Electrical and Electronics Engineering Deprtment
SKSVMACET,
Lakshmeshwar
VTU, Belagavi
shivuyadav052@gmail.com

***Abstract*— The Solar-Based Multi-Proposal Agriculture Robot marks a groundbreaking advancement in modern farming, designed to address the diverse needs of agriculture in India. In response to the demographic significance of agriculture in the country's economy, the robot employs an Arduino UNO R3 as its central control unit. This multifunctional robotic system integrates a range of essential components, including DC motors, relays, ultrasonic sensors, and application-specific tools such as grass cutters, seed sower and water/chemical spray systems. Aiming to propel agricultural mechanization and improve overall productivity, the system control is meticulously orchestrated by the Arduino UNO R3, providing a cost-effective and versatile solution. The integration of DC motors facilitates precise control over wheel movement and cutting operations, thereby enhancing efficiency in the field. Recognizing the need for sustainable energy sources, the robot incorporates solar panels to charge a dedicated battery. This not only ensures uninterrupted operation but also aligns with environmentally friendly practices. This underscores the commitment to safety and reliability, crucial considerations for the widespread adoption of agricultural automation.**

Keywords*— Solar-powered agriculture robot, Arduino UNO R3, precision farming, seed sowing, grass cutting, pesticide spraying, ultrasonic sensor, agricultural automation, DC motor control, sustainable farming, smart agriculture, renewable energy.

I. INTRODUCTION

Agriculture is the backbone of India. The history of Agriculture in India dates back to Indus Valley Civilization Era and even before that in some parts of Southern India. Today, India ranks second worldwide in farm output. The special vehicles play a major role in various fields such as industrial, medical, military applications etc. The special vehicle field are gradually increasing its productivity in agriculture field. Some of the major problems in the Indian agricultural are rising of input costs, availability of skilled labors, lack of water resources and crop monitoring. To overcome these problems, the automation technologies were used in agriculture. The agricultural census gives vital information on the distribution of land holdings in our country. According to the census majority of the farmers are having the land less than 1 hectare.

This is one of the major drawbacks for the ROBOT in agricultural sector in India. The vehicles are being developed for the processes for grass cutting, seed sowing, leveling, water/chemical spray systems. All of these functions have not yet performed using a single vehicle. In this the robots are developed to concentrate in an efficient manner and also it is expected to perform the operations autonomously. The lawn mover is an aid in the mundane task of grass cutting and tending to lawns. Due to the revolution of green movement in the present scenario the industries with major campus areas are changing the percentage of greenery in the campuses and increased greenery causes increased effort and money to tend to. In such cases the lawn mover proves to be an god sent.

Due to increased availability of system on chips, the lawn mover can be automated very easily and also the reduced size and cost of Dc motors causes the system to be independent of fossil fuels to be able to tap into renewable energies. The presence of Ultrasonic sensors and light dependent resistors in a smaller and cheaper packaging cause the brought to be more aware of its surroundings.

Due to the presence of arduino uno in the system causes and increase in the module that can be added. Traditional design of lawn movers had motored powered engines which required regular maintenance such as engine oil and grassing.

They also created a lot of noise pollution and air pollution. In the cold and harsh environment the fossil fuel powered motors tend to freeze and not run. These problems are solved by using electric motors. They are also much more greener because they use solar panel. The mover uses battery chorded system causes a range as limitation and damage to the chords.

The Multipurpose Agricultural Robot typically consists of a robust chassis mounted on wheels or tracks for easy movement on different types of farmland terrain. It is powered by renewable energy sources such as solar panels or rechargeable batteries, making it environmentally friendly and cost-effective in the long run. The robot is equipped with various mechanical attachments or modules that can be interchanged based on the specific task — such as a tool, seed sowing unit, spraying nozzles, or a cutter for weeding.

Fig. 1. Solar Agro Tech Rover

The working principle of this robot is based on the combination of automation, mechatronics, and control systems. The robot is controlled either manually through a remote control or autonomously using programmed instructions and sensors. For example, in the sowing mode, the robot's seed dispenser ensures uniform seed spacing and depth, which helps improve germination rates. In the spraying mode, the robot can identify the crop and spray the required amount of pesticide or fertilizer precisely where needed, reducing chemical usage and preventing pollution.

The robot's sensors play a vital role in detecting environmental conditions such as soil moisture, temperature, and humidity. These inputs help the robot make intelligent decisions, such as when to irrigate or fertilize. Some advanced models also use computer vision and machine learning techniques to recognize weeds and remove them selectively, thereby promoting healthier crop growth.

A. Problem Statement

1) Grass Cutter

Conventional grass cutters face limitations in applications where human supervision is impractical. Powered by fossil fuels, they result in variable costs, labor requirements, and difficulty in navigating diverse terrains. Moreover, the collection of mowed waste necessitates labor-intensive efforts or cumbersome vacuum setups. This project aims to develop a solar-powered multipurpose agriculture robot that addresses these challenges, reduces operational costs, and leverages renewable energy. The system will not only enhance precision in grass cutting but also autonomously drag trimmed waste to facilitate easy collection, ultimately contributing to the beautification of yards.

2) Water Spray & Pesticide Spray

Traditional farming techniques involve manual spraying of pesticides, causing health issues for farmers and demanding significant labor. To modernize this process, an autonomous controlled by a 2.4GHz Radio Frequency Wireless Controller is proposed. This seeks to alleviate the workload of farmers by autonomously spraying pesticides and potentially handling other tasks related to crop management. By incorporating automation, this project aims to enhance efficiency, reduce health risks associated with manual pesticide application, and provide available solution to the challenges faced by farmers in traditional farming practices.

3) Seed Sowing Robot

Traditional seeding methods suffer from several limitations, including uneven distribution of seeds, poor control over seed placement depth, high labor requirements, and inaccuracies leading to uneven plant stands. This project addresses these challenges by proposing a robotic seed sowing. The primary goals are to achieve uniform seed distribution, precise seed placement, and reduce labor demands associated with traditional seeding practices. By automating the seeding process, the system aims to enhance overall efficiency in sowing, particularly in regions practicing dry farming conditions, ultimately contributing to improved crop yields and resource optimization.

B. Objectives

- **Automation of Farm Operations:** Performing essential tasks like ploghing, seed sowing, water sprinkling/irrigation, pesticide/fertilizer spraying, and weeding autonomously.
- **Reduction of Human Effort and Labor Costs:** Minimizing the need for manual labor, which addresses labor shortages and reduces physical strain and associated health issues for farmers.
- **Use of Renewable Energy:** Utilizing solar power as a primary energy source to reduce dependence on fossil fuels (diesel/petrol), thereby lowering operational costs and mitigating environmental impact (reducing carbon emissions).
- **Enhancing Precision and Efficiency:** Employing sensors (soil moisture/PH, temperature) and technologies like GPS and AI for precision agriculture, ensuring optimal seed placement, efficient water management, and targeted application of pesticides/fertilizers to maximize crop yield and quality while minimizing waste.
- **Crop Monitoring and Disease Detection:** Integrating cameras and AI algorithms to monitor crop health, detect pests and diseases at an early stage, and send real-time alerts to farmers, preventing significant crop loss.
- **Cost-Effectiveness**: Designing a multi-purpose and affordable machine, particularly useful for small-scale farmers who cannot afford heavy, expensive traditional machinery.
- **Adaptability:** Creating a robust, autonomous system capable of navigating various field conditions and terrain types without constant human supervision.

II. LITERATURE SURVEY

1. **Design and Implementation of a Multi-functional Agricultural Robot for Spraying, Seeding, and Fertilizing" (2021):** This paper describes a multi-functional agricultural robot capable of spraying water, pesticides, and fertilizers, as well as sowing seeds. The robot is equipped with various sensors and actuators, allowing it to perform these tasks autonomously and with high precision.
2. **Design and Field Testing of a Multi-purpose Agricultural Robot for Seeding, Weeding, and Fertilizing (2020):** This paper describes the design and field testing of a multi-purpose agricultural robot

capable of seeding, weeding, and fertilizing. The robot is equipped with interchangeable modules for each task, allowing it to adapt to different agricultural needs.

3. **In Saurabh Umarkar and Anil Karwankar**: Underline the effect of unavailability of skilled workers in the farming occupation and use of machinery is very vast. So it presents a design and development of a robot which will perform the functions of ploughing, seed sowing and also to detect obstacles in the way. The result of this model shows how the seeds are placed in the field at different intervals. The advantage of such model is that it increases productivity in the farm and also operates on a renewable energy source of solar power.
4. **In K Durga Sowjanya, R Sindhu, M Parijatham, K Srikanth, P Bhargav:** Discuses on the look, design and model of the autonomous agriculture robot. The main motive is to decrease the labor force and provide efficient way for it. It implements the use of Microcontroller and Bluetooth technology and helps in digging the soil, seeding, leveling the soil and then water spraying over the soil. The paper highlights how the robot can be controlled using just a simple Android app. The advantages of such simple model is that it is compact, lightweight and economic for the farmers also.

III. METHODOLOGY

A. Working of Methodology

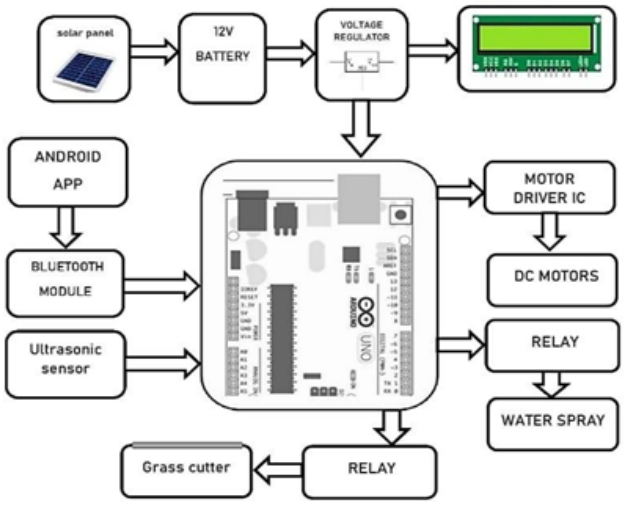

Fig. 2. Block Diagram

The solar-powered robotic grass cutter project incorporates a variety of components, each playing a vital role in the system's functionality. At the heart of the project is the Arduino UNO R3 microcontroller, serving as the central processing unit for computational and logic operations. This versatile microcontroller is responsible for initializing the system upon startup and coordinating the interplay between various components. Facilitating wireless communication and user inter action is the HC-05 Bluetooth module, allowing for remote control and seamless data transfer. The solar panel, a pivotal component, harnesses solar energy to power the system, providing an environmentally friendly and sustainable alternative to traditional electrical sources. A 12V rechargeable battery complements the solar panel, ensuring continuous operation during periods of low sunlight or emergencies, enhancing the system's reliability. Critical to the project's mobility and functionality are the DC motors, driven by a motor driver L293D IC, which enables precise control over the ROBOT movement.

The ultrasonic sensor, another key element, constantly monitors the surroundings, detecting obstacles and providing real-time data to the Arduino. This information guides the robot in intelligently navigating around obstacles, ensuring safe and obstacle-free operation.

The multi-change seed sower offers precise seed placement This Small Seed Sower will sow seeds in straight uniform rows. With six adjustable settings, WE be able to sow different seeds sizes with ease. To enhance user interaction and provide real-time insights, an LCD display communicates vital information about the system's status and power usage. This user interface ensures that the operator has comprehensive control and monitoring capabilities. The entire system operates autonomously, executing pre-programmed instructions or adjusting behavior based on sensor inputs, showcasing the project's advanced automation features.

The development methodology for the solar-powered multipurpose agriculture robot involves a systematic approach, starting with a clear definition of the project's objectives, which include functionalities like grass cutting, seed sowing, and pesticide/water spraying. Component selection is a critical phase, emphasizing the careful selection of efficient components such as sensors, motors, Arduino UNO microcontroller, HC-05 Bluetooth module, 16x2 LCD display, and a reliable PCB for seamless integration.

IV. RESULT

The solar-powered robotic grass cutter project in corporate a variety of components, each playing a vital role in the system's functionality. At the heart of the project is the Arduino UNO R3 microcontroller, serving as the central processing unit for computational and logic operations. This versatile microcontroller is responsible for initializing the system upon startup and coordinating the interplay between various components. Facilitating wireless communication and user interaction is the HC-05 Bluetooth module, allowing for remote control and seamless data transfer. The solar panel, a pivotal component, harnesses solar energy to power the system, providing an environmentally friendly and sustainable alternative to traditional electrical sources.

A 12V rechargeable battery complements the solar panel, ensuring continuous operation during periods of low sunlight or emergencies, enhancing the system's reliability. Critical to the project's mobility and functionality are the DC motors, driven by a motor driver L293D IC, which enables precise control over the ROBOT movement. The ultrasonic sensor, another key element, constantly monitors the surroundings, detecting obstacles and providing real-time data to the Arduino. This information guides the robot in intelligently navigating around obstacles, ensuring safe and obstacle-free operation.

Fig. 3. Working Module

A. OUTCOMES

a) Increased Efficiency:

Automatic asks like seeding, weeding, and harvesting, reducing labor requirements and improving productivity.

Improved Crop Yield:

Precision farming techniques and real-time monitoring lead to heal their crops and higher yields.

b) Water Conservation:

Optimized irrigation systems and soil moisture monitoring reduce water waste.

c) Reduced Chemical Usage:

Targeted application of fertilizers and pesticides minimizes environmental impact.

d) Enhanced Sustainability:

Solar power and eco-friendly practices promote sustainable agriculture.

e) Cost Savings:

Reduced labor, water, and chemical costs improve farm profitability.

f) Data-Driven Decision Making:

Collect and analyze farm data for informed decisions and optimized farming practices.

g) Improved Accessibility

Enables farming in remote or hard to reach areas, expanding agricultural capabilities.

B. ADVANTAGES

- Environment friendly device causing zero pollution to surrounding and renewable energy is made used for every action.
- Portable device easy to carry anywhere any time.
- Cost efficient as manual labor and fossil fuels are eliminated.
- Weight of the machine is reduced.
- Compact and easy to park the machine.
- Efficiency is more than normal mowers.
- Precision Farming: Enables accurate and targeted application of resources for optimal crop yield.
- Efficiency Boost: Automation leads to faster completion of tasks, enhancing overall operational efficiency.

C. DISADVANTAGES

- Cost: High initial investment in specialized components.
- Complexity: Advanced technology requires operator training.
- Maintenance: Increased need for skilled technicians.
- Adaptability: Limited performance in diver sector rains.
- Sunlight Dependency: Weather conditions impact solar-powered operation.
- Payload Capacity: Constraints on carrying equipment or materials.

D. APPLICATIONS

1. Versatility The robot excels in large-scale farming, automating tasks like grass cutting, seed sowing, and spraying, reducing labor costs, and boosting productivity.
2. Commercial plantations of fruits, vegetables, or cash crops benefit from the robot's precision in tasks such as seed sowing and harvesting assistance.
3. Golf courses and sports fields can use the robot for autonomous grass cutting, ensuring a consistently well-maintained playing surface.
4. Urban farming and community gardens benefit from the robot's efficiency in managing small-scale cultivation.
5. High-tech farms integrating precision agriculture methods optimizer source usage and enhance overall farm management with the robot.
6. Agricultural educational institutions utilize the robot as a practical tool for teaching students about modern farming technologies and automation.

V. CONCLUSION

The capacity of the battery was 2000mAh and discharging current was 1.2 amps and the output of the solar panel was 12 v and 5 watts. The discharging time was calculated by dividing the battery capacity by the discharging current. The discharging time was 2 hours approximately. Using the formula E=VIT, we calculated the charging the time which was approximately 4 and a half hour. The previous systems were studied and a suitable design was made. The schematic for the same was made on which prototyping will take place. The components have been chosen based on design requirement and based on a few

other parameters. Based on data collected from research papers, we made a few changes to make our design better. A timeline was made with the knowledge of the review dates and work has proceeded according to it. In the second review we have made a proto type model of the hardware and software system with a demonstration with ultrasonic and infrared sensor. The proto type is on a metal sheet chassis and the detection was done using ultrasonic sensor and the output was obtained. The green revolution has caused a burst in the lawn area and the requirement for a bot. Since grassing cutting is a mundane task requiring a lot of time; it is believed that human time should not be wasted on such tasks or a least reduced to the bare minimum. The cost effectiveness and the ease provided makes the to be a necessity instead of a luxury.

VI. FUTURE SCOPE

In the current state the is capable of completing its objective with 100% success. But with the changing trends in technology were features can be added with the increasing feasibility of the components Some of the proposed features are:

1. Using Geo Fencing technology the can be made capable of tackling more complex boundary shapes with higher precision.
2. Using a GSM module the can made capable of sending and receiving messages from the user's mobile phone through SMS.
3. Boundary area calculations can be made more precise by more complex algorithm designs and estimates of time and energy required can be displayed.

REFERENCES

[1] J. Tarancon et al., "Ag robot: A robot capable of performing agricultural tasks such as ploughing, sowing and seed covering with autonomous navigation and obstacle detection," 2016.

[2] F. Fernandez et al., "VITA: A robot for vineyard management performing weed control, spraying and grape harvesting using computer vision and LIDAR," 2019.

[3] Z. Zhang et al., "RM-R5: A rice farming robot capable of seeding, fertilizing and weed control using RTK-GPS for accurate positioning," 2021.

[4] E. G. Passmore, "Improvement in lawn mowers," U.S. Patent RE 8560, Feb. 23, 1869.

[5] E. L. Hall, "A survey of robot lawn mowers," Available: Retrieved Oct. 6, 2015.

[6] J. Hammond and R. Rafaels, "Build the Lawn Ranger," Radio Electronics, Jun. 1990.

[7] R. Zondlo, "Remote controlled guidance system for working vehicle," U.S. Patent 5,461,292, Oct. 24, 1995.

[8] A. Colens, "Continuous and autonomous mowing system," U.S. Patent 5,444,965, Aug.