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Design And Development Of Cost-Effective Solar Powered Remote Controlled Grass Cutting Lawn Mower

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ABSTRACT: The design and development of Cost effective solar powered remote controlled grass cutting lawn mower is presented in this project with the aim of increasing demand for eco-friendly and energy-efficient solutions has encouraged the adoption of renewable energy technologies in everyday applications. This project focuses on the design and development of a cost-effective solar-powered remote-controlled grass cutting lawn mower aimed at reducing dependence on conventional fuel-based equipment. The system utilizes solar energy as its primary power source, which is stored in a rechargeable battery to operate the cutting motor and drive system.

A remote-control mechanism is incorporated to enhance user safety and convenience, allowing the mower to be operated from a safe distance, especially in uneven or hazardous terrains. The mower is designed with a lightweight structure and a simple mechanical arrangement to minimize overall cost while maintaining satisfactory performance. Readily available components are used to ensure easy maintenance, reliability, and scalability.

The developed prototype demonstrates efficient grass-cutting capability with reduced operational cost, zero fuel consumption, and minimal environmental impact. This project proves the feasibility of using solar energy for small-scale outdoor applications and promotes sustainable engineering practices. With further improvements such as higher-efficiency solar panels, optimized energy storage, and partial automation, the system has the potential for wider domestic, agricultural, and commercial applications.

I. INTRODUCTION

Traditional lawn mowers are usually operated manually or powered by petrol or electricity. While effective, these conventional mowers can cause air pollution, noise pollution, and high operating cost, and they often require significant human effort. With increasing awareness of environmental protection and energy conservation.

This trims the grass utilizing very little time and also optimizes the human power involvement to a minimum level. Based on the one requirement several types of Grasscutter are available to assist one in having the best Grasscutter. Even the power source for the grass cutter plays a vital role while designing the best tool for the user end. Technology oriented cutting down the grass has been implemented adopting modern energy sources such as battery powered by solar panel.

The fully automated solar grass cutter is a revolutionary robotic vehicle designed to cut grass without human intervention, powered entirely by solar energy. Utilizing 12V batteries for motor and cutter operations, it eliminates the need for external charging, making it an eco-friendly solution. Controlled by a remote controller and grass cutter intelligently precise cutting. This project aims to alleviate the burden of lawn maintenance for consumers while reducing environmental and noise pollution.

Traditional grass cutters powered by gas engines contribute to pollution and require frequent maintenance, posing inconvenience and safety hazards. In contrast, solar-powered grass cutters offer a cleaner, quieter alternative, charging efficiently from sunlight. The essential components of a solar-powered grass cutter include solar panels, batteries, motors, and blades. By harnessing solar energy to charge the battery, the motor drives the blade to cut grass effectively. Various approaches, such as retrofitting existing mowers or building from scratch, offer flexibility in design and customization. Moving towards solar-powered lawn maintenance aligns with efforts to mitigate climate change and promote sustainability.

By reducing reliance on fossil fuels and optimizing efficiency through automation, this project represents a significant advancement in lawn care technology. Ultimately, it aims to enhance user experience, productivity, and environmental stewardship in lawn maintenance practices.

A lawn mower operates on the principle of cutting grass to an even height, allowing it to maintain a healthy appearance while preventing weeds and pests from thriving. At its core, the mower uses a rotating blade system that slices through grass as it moves forward, often aided by the use of wheels. This cutting action is achieved efficiently by harnessing either gasoline or electric power, which drives the blade mechanism.

The design of a typical lawn mower includes a deck, which houses the rotating blades, as well as a collection system, either a bag or a mulch feature, that collects or redistributes the grass clippings. The combination of these components allows for effective grass cutting and disposal, meeting the needs of various lawn care enthusiasts.

II. LITERATURE REVIEW

The advanced technology driven machines are leading the engineering of coming up new tools. The IoT-enabled solar-powered grass cutter harnesses radiant energy from the sun as its primary power source and further, the machine integrates IoT technology to enable it to process the trimming of grass with improved efficiency and minimal human intervention. This type of technology driven grass cutter is especially valuable for maintaining vital areas like hotels, stadiums, parks, and public spaces. A new IoT based solar energy powered grass cutter design is reported. The final designed grass cutter components work seamlessly to automate grass cutting operations in outdoor spaces towards ensured effective and obstacle-free processing of the Task.

The study presents the design and development of a solar-powered robotic grass cutter that integrates renewable energy with automation to reduce manual labor and environmental impact. The robot uses solar panels to charge a battery, which powers the cutting blades and drive motors. A microcontroller-based system manages movement and cutting operations, aiming for efficient lawn maintenance. The project highlights the advantages of eco-friendliness, cost-effectiveness, and reduced dependency on fossil fuels, while also addressing challenges such as battery efficiency, navigation, and durability on uneven terrain the task.

The project is to design a programmable grass cutter with solar power which no longer requires time-consuming manual grass cutting. It operated wirelessly using an Android Smartphone through Bluetooth from a safe distance which is capable of cutting grass within a range of 100m.

The main focus was to design that can work with little or no physical user interaction. Also, with the assistance of sensors positioned at the front of the vehicle, an automatic barrier detection system is introduced to enhance safety measurements to prevent any risks. This Project helps in reducing environmental and noise pollution

The basic project idea is to develop a grass-cutting robot controlled with help of the android application. Here the Bluetooth module is used to connect raspberry pi with the phone and in which the reading of the ultrasonic sensor is stored on IOT platform. Previously the grass cutter machines are operated by fuel which is costly. Here the solar panel is utilised to charge the battery so that it doesn't have to be charged externally. The sun-based energy source is more straightforward to utilize, more profitable contrasted with other energy and it is not difficult to work. By the use of solar panels, we can use sunlight to generate electricity free of cost. The solar panel is used to charge the battery for grass cutting purposes. The movement of the machine is totally controlled by using the Android app. The controlling device of the system is Raspberry pi.

UNO-based Solar powered Grasscutter designed to cut healthy grass in places like parks, hotels, public places. The Grasscutter is designed through IoT (Internet of Things) technology, which is controlled remotely through Blynk application supported with Bluetooth module. The proposed Project consists of hardware components like Arduino UNO, Solar panel, DC motor, motor driver, rechargeable batteries and Bluetooth module. The designed model is programmed through Arduino IDE to control the operation of the Grasscutter. The control mechanism and movements such as Forward movement, Backward movement, Right movement, left movement, on mechanism, off mechanism and Stop function for the Grasscutter prototype. An ultrasonic sensor connected to the head of the model avoids the system from colliding with obstacles while in movement.

This study was designed to clean the school field in an easier, faster, safer and more cost-effective way. The device has the following hardware such as Arduino Uno microcontroller, HC-05 Bluetooth module, WIFI module, two 12volt wiper motors as wheels, 24volt E Bike blade motor, motor driver, two caster wheels, switch and two 12volt 7 Ampere rechargeable lead acid battery that are connected in series. The device can be used using Android phone with installed ENIRO App. The ENIRO App was constructed using MIT App Inventor. In controlling the lawn mower, Bluetooth and WIFI connection can be used. The maximum distance of Bluetooth is up to 58 meters or 190 feet. The maximum distance of WIFI connection is up to 152 meters or 500 feet. In continuous usage of the device up to two hours, the area of mowed grass is 30 meters by 20 meters. The project passed the project evaluation and determined the quality of the project.

III. SYSTEM OVERVIEW

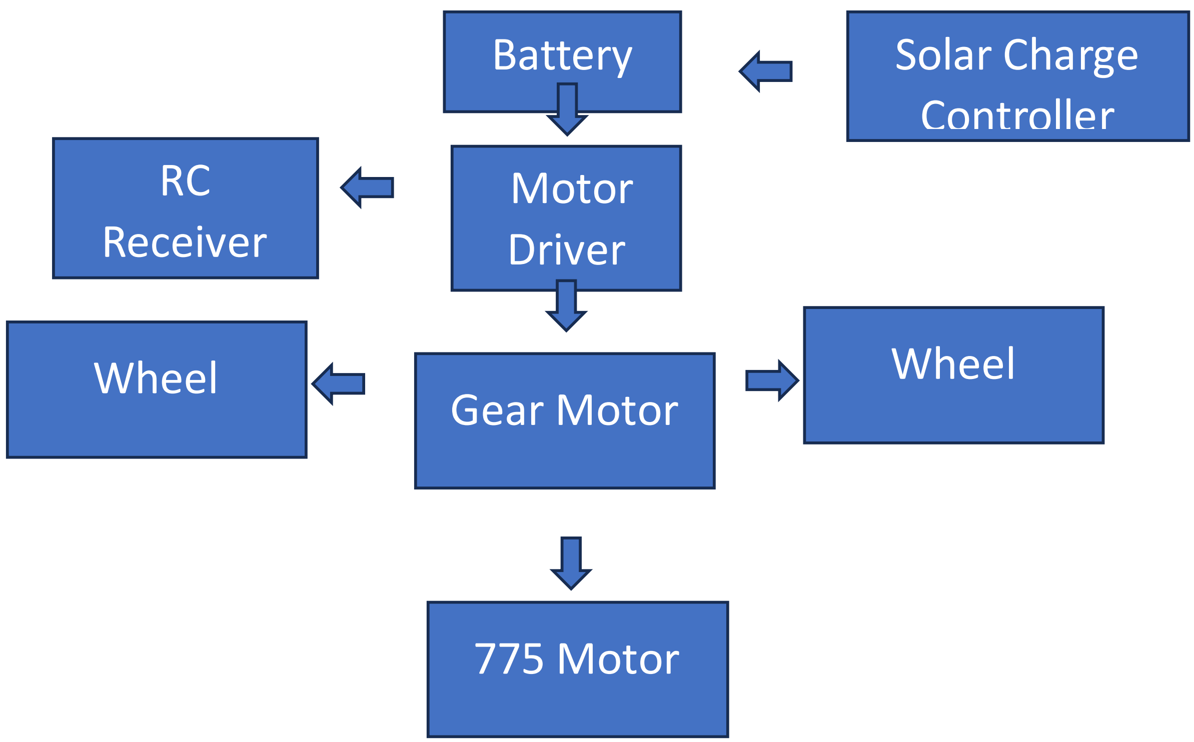


Fig : - Block diagram of solar powered remote controlled grass cutting lawn mower.

The methodology outlines the systematic steps undertaken to design, develop, and implement the cost-effective solar powered remote-controlled grass cutting lawn mower. The process is divided into phases to ensure a structured approach toward problem-solving and development.

The grass cutter, composed of various components, features two built-in reduction gear mechanism motors for driving the vehicle, along with a high RPM DC motor dedicated to grass cutting. This cutting motor is equipped with a fan fitted with sharp blades. Other essential elements include a rechargeable battery, solar panel, control unit with a microcontroller, motor drivers, and a linkage mechanism. The power and charging system rely on a solar panel, which charges the battery during exposure to sunlight. The DC motor serves as the central driving force, propelling the collapsible blades forward for cutting. Activation of the system is facilitated by an electrical switch that completes the circuit connecting the DC motor and the battery.

The design process began by identifying the key functional needs of the system, which included effective grass cutting, smooth remote-controlled mobility, and the use of solar-based power to ensure energy efficiency and sustainability.

Based on these requirements, appropriate component specifications were determined, such as selecting a motor with sufficient power, defining the required blade speed for efficient cutting, choosing a battery with adequate capacity for continuous operation, and deciding on a suitable solar panel wattage to support charging needs. In addition, environmental and operational conditions were analysed, particularly factors like sunlight availability and operating terrain, to ensure reliable performance and proper integration of the solar power system under real-world conditions

The system development involved creating a detailed mechanical layout that defined the chassis design, proper motor placement, secure blade mounting, and optimal positioning of the solar panel to maximize energy capture. Alongside the mechanical design, a complete electrical layout was prepared, including wiring diagrams for the battery, charge controller, motor drivers, and remote receiver to ensure safe and efficient power distribution and control. Additionally, all subsystems were carefully evaluated to ensure compatibility in terms of voltage and current requirements, enabling reliable integration and smooth operation of the entire system.

Appropriate DC motors were selected to meet the power and torque requirements for both the driving mechanism and the grass-cutting operation. A suitable solar panel in the range of 10–40 W was chosen along with a 12 V battery to ensure reliable energy storage and continuous operation. Communication modules, including a remote receiver, were selected to enable efficient and responsive remote control of the system. Additionally, lightweight yet durable materials were finalized for the chassis to provide structural strength while maintaining ease of mobility and overall efficiency.

The chassis was fabricated using metal to provide strength and durability to the overall structure. The motors, wheels, and cutting blade were securely mounted to ensure stable and reliable operation during movement and grass cutting. Protective guards were installed around the cutting blade to enhance safety and prevent accidental contact. Additionally, proper alignment of components and an appropriate centre of gravity were ensured to achieve smooth movement, balance, and effective performance of the system.

The electrical system was assembled by integrating the solar panel with a charge controller and battery to enable efficient energy harvesting and storage. Motor driver circuits were wired to both the drive motors and the cutting motor to allow precise control of movement and cutting operations. The remote-control receiver was connected to the control circuitry to facilitate wireless operation of the system. Additionally, proper insulation and careful cable routing were ensured throughout the setup to prevent damage, reduce electrical hazards, and improve the overall reliability of the system.

The system was thoroughly tested by performing movement trials on various surfaces to evaluate manoeuvrability and stability. Cutting performance was assessed on different grass heights to ensure effective and consistent operation of the blade. The efficiency of the solar charging system was evaluated under varying sunlight conditions to verify reliable energy generation.

Battery backup and runtime were also measured during full operation to determine endurance. Based on these tests, issues were identified and necessary adjustments were made to optimize performance, reliability, and overall efficiency of the system.

The final stage involved integrating the mechanical, electrical, and control subsystems into a single, fully functional unit. Comprehensive system testing was then conducted under real outdoor conditions to assess overall performance and reliability. The mower was validated based on key metrics such as cutting performance, operational safety, and energy efficiency. Finally, all final design parameters, test results, and operational guidelines were documented to support proper usage, maintenance, and future improvements

CALUCLATION

The below shown calculations indicate the efficiency, and performance of the solar panel and battery charging system and help in selecting suitable charging methods to estimate the battery charging time and operating time of a 12 V, 7.2 Ah lead-acid battery in a practical system.

Lead-acid battery charging time from solar panel

Solar panel voltage = 12V

Solar panel power = 20W

I = Power/voltage = 20W/12V **= 1.66A**

Battery capacity: 12V, 7.2Ah

Charging efficiency 80%

Effective battery capacity (considering losses) = 7.2/0.80=9Ah

Charging time = 9Ah/1.66A=5.42 hours.

Battery charging time using a 20W solar panel **= 5.42 hours**

Battery = 12V, 7.2Ah

Load currents:

I = I1+I2 = 2A+2A = **4A**

T = Battery capacity (Ah)/total current(I)

T = 7.2/4 = **1.8hours**

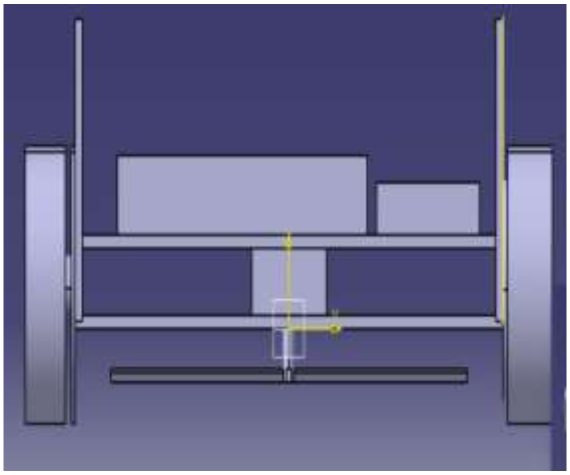
Charging time using DC charger 12v, 7.2Ah

Effective Ah needed = 7.2/0.80 = 9Ah

Battery charging time: T = 9Ah/7A = **1.29 hours.**

IV. EXPERIMENTAL SETUP

CAD Modelling and Engineering Drawing



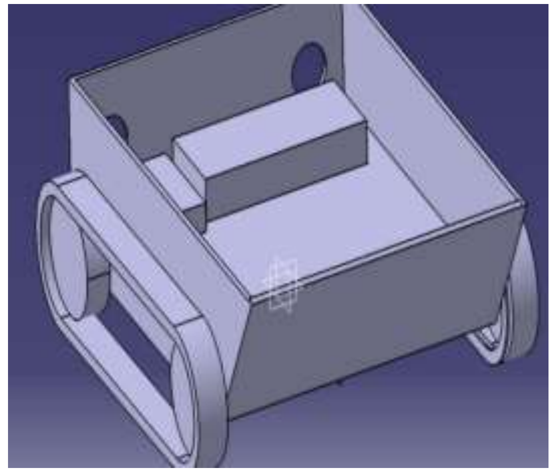


Fig. (a) **Fig. (b)**

Fig. 6.1: -Fig. (a) and (b) represents 3D front and top view of lawn mower respectively.

Fig. (a) and (b) shows the 3D designed using CAD application. Fig. (a) is the front view of 3D and fig. (b) shows the wide angle of grass cutting lawn mower. The initial CAD model was developed using solid works, ensuring accurate visualization before fabrication. The project includes detailed chassis frame design, motor mount, and component placement for structural integrity and performed to provide precise manufacturing dimensions.

Mechanical Design and Manufacturing Process

Fig. (a) **Fig. (b)**

Fig.: - Fig. (a) and (b) represents welding process of lawn mower base

Fig. (a) and (b) shows the welding process of making the lawn mower base it is done by galvanized iron and the mechanical structure of the solar powered remote controlled grass cutting lawn mower was designed to ensure stability, strength and efficient load handling. The fabrication process including material section, manual cutting, welding, and surface treatment.

Electrical components assembling to chassis

Fig.: -Represents components assemble to chassis frame

The above fig 7.3.1 shows the electrical components placement and testing the working of components after assembling to chassis. includes detailed chassis frame design, motor mount, and component placement for structural integrity

Mounting chassis frame

Fig. (a)

Fig. (b)

Fig. (c)

Fig.: - Fig. (a), (b) and (c) shows different views of mounting of chassis frame.

The fig.(a) shows the cutting of the sun board sheet according to chassis measurement; fig.(b) shows the sun board sheet mounted to chassis and fig.(c) shows fixing of motor in bottom of chassis which is used to cut the grass at uniform height.

V. RESULTS AND DISCUSSION

The cost-effective solar-powered remote-controlled grass-cutting lawn mower operates efficiently by utilizing solar energy to charge its battery through a solar charge controller, which manages both charging and discharging to ensure safe and optimal power usage. This system allows the mower to run independently of conventional power sources, reducing operational costs and promoting sustainability. During operation, the mower successfully cuts grass to a uniform height, providing consistent and precise lawn maintenance. Its combination of solar charging, automated control, and efficient cutting makes it a practical and eco-friendly solution for maintaining well-manicured lawns with minimal effort.

Fig.: - Design and development of cost-effective solar powered remote controlled grass cutting lawn mower

The system reduced dependence on conventional electricity or fuel, environmentally friendly and cost-effective over long-term use. the mower delivers consistent and accurate cutting performance, ensuring uniform grass height and improved lawn appearance. this system improves operational efficiency, saves time, lowers maintenance effort, and promotes sustainable practices, making lawn care more convenient and effective for users.

VI. CONCLUSION

The design and development of a cost-effective solar-powered remote-controlled grass cutting lawn mower successfully addresses the limitations of conventional grass cutting methods. By utilizing renewable solar energy, the system reduces dependence on fossil fuels and grid electricity, thereby minimizing operating costs and environmental impact.

Remote control operation enhances user safety and convenience by reducing physical effort and exposure to hazards. The use of affordable and easily available components makes the mower economical and suitable for domestic, institutional, and small-scale applications. Overall, this project demonstrates a practical, eco-friendly, and efficient solution for modern lawn maintenance. The developed system proves that renewable energy can be effectively utilized for small-scale outdoor applications without compromising performance. The remote-controlled feature enhances user safety and convenience, especially in uneven or hazardous terrains, while the lightweight and simple mechanical design keeps the overall cost affordable. The use of readily available components further supports easy maintenance and scalability.

Overall, this project highlights the feasibility of adopting green technology in everyday applications. With further improvements such as higher efficiency solar panels, battery optimization, and partial automation, the system can be enhanced for wider domestic, agricultural, and commercial use. The project thus contributes positively toward sustainable engineering solutions and encourages the adoption of clean energy technologies in lawn care equipment.

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