Design and Fabrication of Solar Brush Cutter

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Abstract - A solar brush cutter is a machine that is used to clear dense vegetation and thick brush in an outdoor area. It operates using solar power, which is harnessed through a solar panel that converts sunlight into electricity to power the motor that drives the cutting blades. The use of a solar brush cutter is an eco-friendly and cost-effective alternative to traditional brush cutters that rely on fossil fuels. This does not eliminate harmful emissions, requires minimal maintenance, and can operate for longer periods without the need for refueling. Solar brush cutters are designed to handle tough vegetation and can cut through dense areas with ease. They are ideal for use in remote locations where access to traditional fuel sources may be limited or expensive. Additionally, they are quieter than traditional brush cutters, making them a preferred choice for noise-sensitive environments. The use of solar brush cutters is a sustainable and efficient way to clear brush and maintain outdoor spaces. As solar technology continues to improve, the efficiency and effectiveness of solar brush cutters will only continue to improve, making them an even more attractive option for outdoor maintenance.

***Key Words*: - Solar operated, Brush cutter, eco-friendly, cost-effective, Solar panel, Dc motor**

1.INTRODUCTION

Solar brush cutters are innovative devices that utilize renewable energy from the sun to power the cutting blades, providing an eco-friendly and cost-effective alternative to traditional gasoline-powered brush cutters. These devices are designed to cut through small to medium-s5ized brush and vegetation, making them ideal for use in residential areas and public parks. Solar brush cutters use a solar panel to generate electricity, which is stored in a battery and used to power the motor and cutting blades. The components of the brush cutter include a solar panel, battery, DC motor, cutting blades, frame, control circuit, and wheels. The cutting blades are designed to optimize cutting height and width while minimizing power consumption.The advantages of solar brush cutters are numerous. They are quiet, emission-free, and require minimal maintenance, making them a suitable option for use in areas where noise and pollution are concerns. Additionally, solar brush cutters do not require gasoline, reducing operating costs and dependence on fossil fuels.

In this context, this research paper aims to present the design and fabrication of a solar-operated brush cutter, which provides an eco-friendly and cost-effective alternative to traditional gasoline-powered brush cutters. The paper describes the methodology involved in selecting appropriate components, designing cutting blades, and testing for efficiency and effectiveness. The results show that the solar-operated brush cutter is a practical and effective solution for cutting small to medium-sized brush and vegetation, providing a valuable contribution towards sustainable and environmentally friendly lawn maintenance.

1.1 Identify, Research And Collect Idea

The research paper titled "Solar grass cutter with linear blades by using scotch yoke mechanism" by Amrutesh et al. (2014) presents the design and fabrication of a solar grass cutter that uses a scotch yoke mechanism to convert rotary motion to linear motion. The paper aims to provide a solution for the increasing need for sustainable and eco-friendly lawn maintenance.The paper begins by discussing the current state of lawn maintenance and the environmental impacts of traditional gasoline-powered grass cutters. The authors then introduce the concept of a solar-powered grass cutter and the advantages of using solar energy for lawn maintenance.

The design of the solar grass cutter is explained in detail, including the selection of components, the scotch yoke mechanism, and the linear cutting blades. The scotch yoke mechanism is used to convert the rotary motion of the motor to the linear motion of the cutting blades, which provides an efficient and reliable cutting mechanism. The linear cutting blades are designed to optimize cutting efficiency while reducing power consumption.

The fabrication process is also described, including the assembly of the components and the wiring of the electrical circuit. The authors also provide a detailed explanation of the testing process and the results obtained. The results show that the solar grass cutter with linear blades using a scotch yoke mechanism is a practical and efficient solution for lawn maintenance. The device is eco-friendly, quiet, and cost-effective, making it a suitable option for residential areas and public parks. The authors also suggest potential areas for future research and improvements to the design The research paper titled "Design and Fabrication of Hybrid Operating Grass Cutter" by Rajmani et al. (2019) presents the design and fabrication of a hybrid grass cutter that utilizes both solar and electric power to operate. The paper aims to provide a sustainable and eco-friendly solution for lawn maintenance. The authors introduce the concept of a hybrid grass cutter and the advantages of using both solar and electric power. The design of the hybrid grass cutter is explained in simple language, including the selection of components, the motor, and the cutting blades. The hybrid grass cutter uses solar power during the daytime, and electric power during the night, making it a reliable and efficient device. The fabrication process is also described, including the assembly of the components and the wiring of the electrical circuit. The authors also provide a brief explanation of the testing process and the results obtained

The research paper titled "Design and Fabrication of Lever-Operated Solar Lawn Mower and Contact Stress Analysis of Spur Gears" by Satwik et al. (2015) discusses the design and fabrication of a lever-operated solar lawn mower and analyzes the contact stress of the gears used in the device. The paper begins by describing the need for eco-friendly lawn maintenance solutions and introduces the concept of a solar lawn mower. The authors then explain the design of the lever-operated solar lawn mower, including the selection of components and the lever mechanism used to operate the device. The paper also discusses the contact stress analysis of the gears used in the lawn mower, providing technical insights into the mechanical operation of the device. The authors explain the methodology used to analyze the contact stress of the gears and the results obtained. Overall, the research paper provides valuable insights into the design and fabrication of a lever-operated solar lawn mower, offering a solution for eco-friendly lawn maintenance.

Additionally, the analysis of the gears provides technical information on the mechanical operation of the device, which can aid in further improvements to the design The research paper titled "Fabrication of Solar Grass Cutter" by Malviya et al. (2016) presents the design and fabrication of a solar-powered grass cutter. The paper aims to provide an eco-friendly and efficient solution for lawn maintenance. The paper describes the design of the grass cutter in a simple manner, including the selection of components such as the solar panel, battery, motor, and cutting blades. The authors explain the working principle of the device, which involves converting solar energy into electrical energy to power the motor. The fabrication process is also explained, including the assembly of the components and the wiring of the electrical circuit.

The paper also provides a detailed explanation of the testing process and the results obtained. The results show that the solar grass cutter is an effective solution for lawn maintenance, providing a sustainable and eco-friendly alternative to traditional gasoline-powered lawnmowers. The device is also cost-effective, making it a suitable option for residential areas and public parks.

1.2 Components Used

The main components of the solar brush cutter are,

1.Solar panels 2.Battery 3.DC motor 4.Blades 5. Solar charger

SOLAR PANEL

A solar panel is a device that converts sunlight into electrical energy using the photovoltaic effect. It is made up of multiple solar cells that are connected in a series and housed within a protective frame. Solar cells are typically made of semiconductor materials such as silicon, and when exposed to sunlight, they generate an electric current. The solar panel's output is determined by the number and arrangement of solar cells within it, as well as the efficiency of those cells in converting sunlight into electricity. Solar panels are commonly used in a wide range of applications, from powering homes and businesses to providing electricity to remote locations and spacecraft. They are also an important component in many renewable energy systems, helping to reduce dependence on fossil fuels and lower greenhouse gas emissions.

Fig -1: Solar Panel

BATTERY

A battery is an electrochemical device that stores electrical energy in the form of chemical energy. It consists of one or more electrochemical cells that convert stored chemical energy into electrical energy through a chemical reaction. Batteries come in different sizes, shapes, and chemical compositions depending on the application they are used for. Batteries are commonly used in portable electronic devices such as mobile phones, laptops, and cameras, as well as in electric vehicles, renewable energy systems, and backup power supplies. The capacity of a battery is measured in ampere-hours (Ah) or milliampere-hours (mAh) and determines the amount of energy that can be stored and discharged. There are several types of batteries, including lead-acid, nickel-cadmium (NiCad), nickel-metal hydride (NiMH), and lithium-ion (Li-ion). Each type has its own set of advantages and disadvantages in terms of energy density,

cost, lifespan, and environmental impact. The choice of battery type depends on the specific application and requirements, such as size, weight, and energy storage capacity

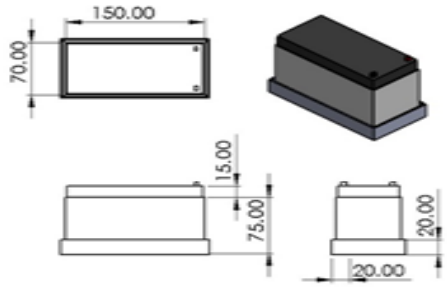


Fig -2: Battery

DC MOTOR

DC motors can be classified into two main types: brushed and brushless. Brushed DC motors have a set of brushes that make contact with the rotor's commutator to change the direction of the current and keep the rotor turning. Brushless DC motors, on the other hand, use electronic controllers to control the direction and speed of the motor without the need for brushes. Brushless DC motors have several advantages over brushed DC motors, including higher efficiency, longer lifespan, and less maintenance.

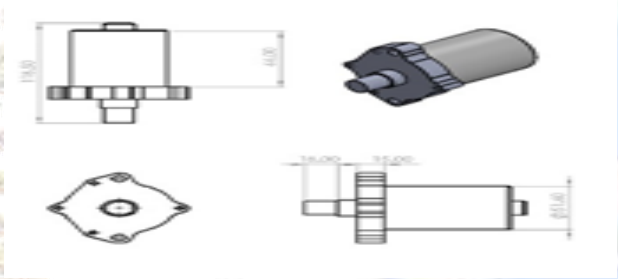


Fig -3: DC Motor

BLADES

The shape and size of the blades can affect the cutting performance of the grass cutter. For example, a larger blade can cover a larger area and cut more grass with each pass, but may require more power to rotate. On the other hand, a smaller blade may require less power but may take longer to cut a given area of grass. The cutting angle and sharpness of the blades can also affect the cutting efficiency and quality, as dull blades can tear the grass instead of cleanly cutting it.

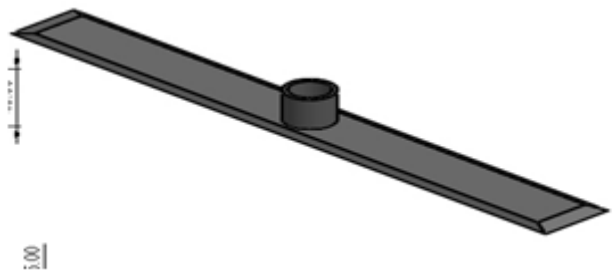


Fig -4: Blade

SOLAR CHARGER

A solar charger is a device that is used to charge batteries or electronic devices using solar energy. It consists of a solar panel that absorbs sunlight and converts it into electrical energy, which is then used to charge a battery or power a device directly. The efficiency of a solar charger depends on the size and quality of the solar panel, as well as the weather conditions and the amount of sunlight available. Some solar chargers also come with built-in batteries to store the energy generated by the solar panel, allowing them to charge devices even when sunlight is not available. Solar chargers offer several benefits over traditional chargers, such as being environmentally friendly, portable, and independent of electrical outlets. They can be especially useful in outdoor and remote locations where access to electricity is limited. However, they may take longer to charge devices compared to traditional chargers, and their performance can be affected by weather conditions.

Fig -5: Solar Charger

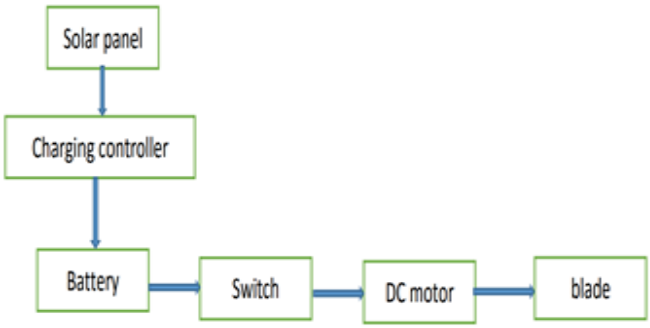
2. METHODOLOGY

Determine the power requirements: The first step in designing a solar-powered brush cutteris to determine the power requirements for the motor that drives the cutting blades. This will depend on the size of the lawn or garden being maintained, the type of grass, and other factors. Select the components: Once the power requirements have been determined, the next step is to select the components for the grass cutter. This will include the DC motor, solar panel, battery, and other components necessary for the design. Design the frame and cutting blades: The frame and cutting blades should be designed to be lightweight, durable, and efficient. The cutting blades should be optimized for cutting grass effectively, with a suitable cutting height and cutting width. Assemble the grass cutter: The brush cuttershould be assembled using the selected components and designed frame and cutting blades. The motor should be attached to the cutting blades, and the solar panel and battery should be connected to the motor. Test and optimize the design: Once the brush cutterhas been assembled, it should be tested to ensure that it is operating efficiently and cutting grass effectively. Any necessary optimizations should be made to improve the performance and efficiency of the grass cutter. Maintenance and operation The brush cuttershould be properly maintained and operated to ensure optimal performance and efficiency. The solar panel should be kept clean and free of debris, and the battery should be regularly charged.

3. WORKING PRINCIPLE

The block diagram of the overall system, as shown in Figure , consists of a 10W, 12V solar panel that provides power to charge a 12V battery. The brush cuttermodel utilizes a DC motor to convert electrical energy into mechanical energy, which is then used to drive the blades for cutting the grass. The system uses a 12V battery to power both the vehicle movement motor and the brush cuttermotor. The solar panel is mounted in a specific arrangement to receive solar energy from the sun, and the solar charger is used to store this energy in the batteries. The motor is connected to the battery and is controlled by a motor drive, which allows for starting and stopping of the motor. The power from the motor is then delivered to the cutting mechanism, which rotates the blades and cuts the grass.

By using this system, the solar panel generates electrical energy from sunlight, which is stored in the batteries for later use. The motor, powered by the batteries, drives the brush cutterblades to cut the grass effectively. The motor drive provides control over the motor's operation, allowing for starting and stopping as needed. The solar charger ensures that the batteries are charged efficiently and safely, preventing overcharging or over-discharging. The 12V batteries provide power not only to the brush cuttermotor but also to the vehicle movement motor, allowing for mobility of the brush cutter.



4. DRAWINGS

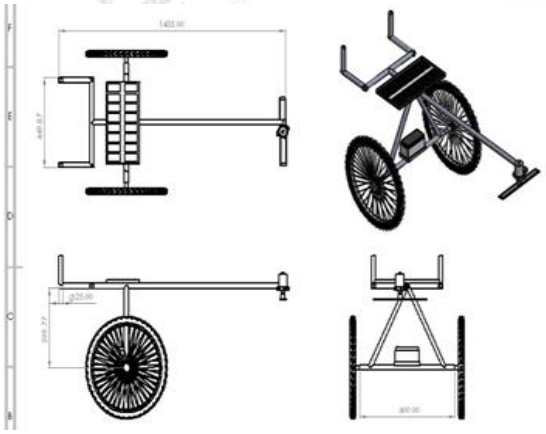


Fig -6

Fig -7

5. CALCULATION

1. Design of motor

Power of shaft=P=50 Watt

Power transmitted by the shaft

$$P=\frac{2\pi*2000*T}{60}*10^3$$

Where N=RPM of motor shaft=2000rpm

T=Torque of transmission

$$50=\frac{2\pi*2000*T}{60}*10^3$$

$$T=0.2387*10^3$$

2. Design of motor shaft

Now, T_1 is the maximum torque among all shafts, so we will check the shaft for failure here

$$T=\frac{\pi\,\sigma s\,D^3}{16}$$

= 18 Hrs.

Discharge Time = (Battery watt/Total watt Consumed)

= 54/50

≈ 1.08 Hours

= 64.8 minutes

3. Design of frame

Let the total weight (P) of our machine be 20 kg, now this 20 kg weight is kept on square pipes, so it may fail under bending.

P = 20 kg.

P = 20 x 9.8 = 200 N.

L = 462 mm.

M = WL/4 = 200 × 462/4

M= 23100 N-mm

Section of modulus = $Z = B^3 – b^3 / 6$

$= 20^3 - 17^3 / 6$

$= 514.5\ mm^3$

Bending stress = M/Z = 23100/514.5 = 44.89 N/mm²

As induced bending stress is less then allowable bending stress i.e. 270 N/mm² design is safe.

1. BILL OF MATERIALS

Sr no	Component	Mareial	No off	Cost
1	Solar Panel(10 watt)	Polycrystalline	1	1000
2	Solar charge controller		1	799
3	Battery(12v)	Lead Acid	1	1195
4	Motor	Aluminum	1	950
g	cable	copper	1	400
6	Blades	HSS	2	100
7	Nuts and Bolts		12	200
8	Cycle wheel		2	
9	Square pipe	MS	5 kg	450
10	Angle frame	MS	5 kg	450

2. RESULT:

The solar-operated brush cutter is an eco-friendly and cost-effective tool that effectively utilizes solar energy as a source of power and can control weeds present in waste lands, bunds, and road sides, with potential for future development in the area of sensor-based cutting to improve motor efficiency.

3. CONCLUSION

The Fabrication of a solar-powered brush cutterproject has been completed successfully, and the obtained results are satisfactory. It is an advantageous project for a common man due to several reasons. Firstly, it doesn't require any fuel cost, making it cost-effective. Secondly, it is an eco-friendly alternative that produces no pollution and leaves no fuel residue. Additionally, this project requires less maintenance due to a smaller number of moving components, resulting in less wear and tear. Lastly, it operates by utilizing solar energy, making it an efficient and renewable source of power. Overall, this project is a suitable option for those who wish to modify it further and promote sustainable solutions.

The solar-powered brush cutteris an excellent solution for promoting physical exercise, as it can be easily handled. Given our proximity to the Equator, solar energy is abundantly available, making it a pollution-free alternative that can charge the battery efficiently. However, the initial investment required for this project is relatively high. Fortunately, the Government of India offers subsidies for solar equipment, which can help offset some of the cost. Additionally, mass production by industries may eventually bring down the overall cost of the system. It is expected that in the future, all equipment will be powered by solar energy, making it an increasingly viable option. One of the advantages of this system is that it allows for the batteries to charge while the brush cutteris in motion, making it more efficient. Additionally, the batteries can charge during the day, allowing for operation at night. Overall, the solar-powered brush cutteris a suitable option for promoting sustainable energy practices while also providing efficient grass cutting capabilities.

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