



Solar powered lawn mover.

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1.1 Introduction

CHAPTER 1 INTRODUCTION

Due to the continuous increase in the cost of fuel and the effect of emission of gases from the burnt fuel into the atmosphere, this necessitated the use of the abundant solar energy from the sun as a source of power to drive a lawn mower.

A solar powered lawn mower was designed and developed, based on the general principle of mowing. The designed solar powered lawnmower comprises of direct current (D.C) motor, a rechargeable battery, solar panel, a stainless-steel blade and control switch. Mowing is achieved by the D.C motor which provides the required torque needed to drive the stainless-steel blade which is directly coupled to the shaft of the D.C motor.

The solar powered lawnmower is operated by the switch on the board which closes the circuit and allows the flow of current to the motor which in turn drive the blade used for mowing. The battery recharges through the solar charging controller. Performance evaluation of the developed machine was carried out with different types of grasses.

The sun provides sustainable amount of the energy used for various purposes on earth for atmospheric system. The difference is just the application of the energy source. It is assumed that a lawnmower using solar as the energy source will address a number of issues that the standard internal combustion engine and electric motors lawn mowers do not.

A lawnmower with solar energy will be easier to use, it eliminates down time by frequent trips to the gas station for fill-ups and danger associated with gasoline spillage. The dangerous emissions generated by the gasoline spillage and that of the internal combustion engine into the atmosphere are eliminated. The solar powered lawnmower will help to reduce air pollution. Thus, solar grass cutter is used.

The use of solar power as an alternative source of energy has been in existence long before now but has not had diverse application methods due to other frequently used sources of energy. Solar energy involves the process of harnessing radiant light and heat from the sun using a range of ever evolving

technologies such as solar thermal energy and photovoltaics. These technologies are broadly characterized as either passive solar or active solar depending on how the energy is converted to solar power. The effectiveness of these technologies has made solar energy a very important source of renewable energy and thereby giving room for new developments in its wide range application processes. In the world today, world's power consumption is taking a shift from the use of common sources of energy such as fossil fuel and wood fuels to solar energy. The change in energy consumption trend was due to the awareness of fossil fuel pollution and its contribution to global warming, and also the fact that fuel energy is non-renewable and unsustainable. In Nigeria today, like most other developing countries, fossil fuel has been a basic source of non-renewable energy. Pending the fact that we import fuel there is always a tendency of a hike in the cost of fuel as a result of the country economic instability. Lawn maintenance is the art and vocation of keeping a lawn healthy, clean, safe and attractive, typically in a garden, park, institutional setting or estate. Man is constantly trying to adapt to his environment by creating a habitat suitable for his survival.

1.2 Existing Systems

To make up student's mind, not only to work individually but also to work in a team. To get the knowledge of each student in various subjects which he has studied before? To prepare a team, not only to make project but, also to decide design, cost of raw material and advantages and limitations of them. The students can know that which and what kind of difficulties and constraints they have to face and find the right decision difficult it.

The aim and objective of this project is to design and fabricate a lawn mower which would be powered by solar energy in addition to the common gasoline engine. The specific objectives are as follows:

- i. To study the design parameter of a solar lawn mower.
- ii. Fabrication of the solar lawn mower.
- iii. Testing of the solar lawn mower
- iv. To analyze the solar lawn mower and compare its performance with gasoline operated mowers.



FIGURE 1.1 A Person with Solar Grass Cutter

1.3 Needs

In the world today where technology is merging with environmental awareness, most people are looking for ways to contribute to the relief of their own carbon foot prints (Badger & Vicky, 2017).

Pollution is manmade, which can be seen in the day-to-day activities of man. In this part of the world, the most common types of lawn mowers are powered by gasoline engines which are hazardous to the environment thereby leading to global warming and depletion of the ozone layer.

Gasoline powered mowers create noise due to the loud engine noise, and air pollution due to the combustion in the engine. Thus, gasoline powered lawn mower contributes to both air and noise pollution. Hence, alternatives to the use of non-renewable energy and polluting fossil fuels needs to be taken into consideration.

1.4 Proposed work

The solar powered lawn mower is set to eliminate both noise and environmental pollution to the barest minimum. The design can be seen as an alternate option to popular and environmentally hazardous gas-powered lawn mower (Kumar & Kanti Prashant). Solar lawn mower is advantageous over gasoline powered mowers because it eliminates environmental pollution which is responsible for the emission of gases that results to global warming on the earth surface. Also,

with the rate at which petroleum products are increasing day by day, the use of solar energy can be seen as a reasonable practice to the use of renewable energy sources to operate lawn mowers by eliminating the use of gasoline fuels which gasoline engines solely depends on.

1.5 Organization of the report

A lawn mower is a ground keeping device that make use of one or more rotating blades to cut a grass surface to an even height. There are various ways used to power a lawn mower, but the use of solar energy as a source of energy to operate a lawn mower is the main focus of this project.

The solar powered lawn mower involves the use of solar energy to charge a direct current battery which supplies the current stored to the motor which in turn enables rotation of the blade for mowing. The solar panel receives energy from the sun, when the sun shines, the solar panel or photo voltaic cell will generate or produce voltage, the energy received from the sun goes into the charge controller. The charge controller is connected in between the panel and the battery. The main function of the charge controller is to monitor and control the flow of current and charge the battery. The charge controller will stop the current flow from the solar panel if the battery voltage exceeds a pre-set level and also stop current flow if the battery voltage drops below a preset level.

CHAPTER 2

Theoretical background

2.1 Literature Review

This chapter gives an extensive review on works and study related to this project, emphasizing on different designs, analysis, areas of application and safety aspects of view. Below is a description containing related publications with the author. In the study of D. Satwik et al design and fabrication of a lever operated solar lawn mower, the main objective was to cut grass at different heights. The proposed lawn mower had a spur gear displacement mechanism in which the rotor blade height can be adjusted by using the lever attached to it and that can proportionally change the height of the grass cut of the lawn and required grass cut can be achieved and this process of adjustment will be completed in less than 20 seconds. The components used in machine fabrication include; DC motor, battery, solar panel, spur gears, wheels, ultrasonic sensor, Arduino board and a rotor blade.

In this process, an electric brushless motor is taken to drive the rotor blade and solar energy is used to drive the motor. The batteries perform charging and discharging action between the solar panel and the motor. The actual mechanism lies between the rotor and the motor using spur gears for the power transformation. The motor runs 45min continuously until the batteries are depleted. The batteries require 23 hours to recharge completely, 10watt solar panel is used and it takes 4 days considering 6 hours' direct sunlight per day to charge complete two batteries. The Arduino board is an open-source computer software program used to control the speed of the motor manually. The corresponding required program is written and dumped into board. In front of the machine is an ultrasonic sensor that provides signal to prevent collision between the machine and obstacles during the cutting operation. The sensor provides signal to the Arduino board before the time of collision (below 30cm from the obstacle). Buzzer receives a signal from the board and produces alarm that prevents the collision. Spur gears were used to transmit power between motor and the rotor. Contact stresses acting on the teeth of their respective spur gears were calculated theoretically using Hertz and AGMA equation.

In monomania et al lawn mower design, the project work was based on improving the design of a solar operated lawn mower forms a locally available sources in Nigeria. It also aimed at improving the cutting efficiency when compared to the conventional fossil fuel powered lawn mower. The components used for this design include; a 12V, 35Ah battery, 100W, 7.5A solar panel, charge controller, 1HP, 62.14A D.C motor and a stainless-steel plate. In this machine operation, there are fire inlets at different points outside the mower that draws in air into the center of the blade as it revolves. The air is push down creating a high-pressure rating of underneath the machine. This high-pressure rating creates lift, raising the mower on inclusion of air which also allows the mower to be easily maneuvered. When the mower moves, the lawn mower blades which are attached to the revolving of the D.C motor cut the grass. The electric circuit ensures power transfer from the battery to run the D.C. motor, while the solar panel power, and continuously recharge the battery while in operation. When the power switch is on, the electrical energy from the battery powers the

motor which in turn actuates the blades. The solar panel generates current to recharge the battery, thereby compensating for the battery discharge. The solar lawn mower is made up of a lawn mower deck with handle, a 24 volts DC motor two 12 volts' battery and a sickle-shaped blade. A charge controller is mounted separately used for charging the batteries. The solar panel is a photovoltaic cell that generates current when light falls on its surface. Two 100 Watts solar panels connected in series are used to charge the batteries. The D.C. motor forms the heart of the machine and provided the driving force for the cutting blades. Physical properties were obtained for three blades considering their maximum and minimum von misses stress. The concepts examined were for a tapered shaped blade, for a flat blade design and for a sickle like shaped blade. After the design analysis, concept three which involved the use of a sickle like shaped blade was selected for the lawn mower design and formed the basis for all the calculations considered.

Natarajan et al designed and fabricated a lawn mower using a helix shaped blade. The innovation concept was to fabricate a grass cutting machine for use in an agricultural field and also to design the grass cutter without any power source so as to reduce the power consumption. The wheel rotation is achieved by human power as the machine is being pushed by the operator. The components used for the fabrication includes; a wheel, gear arrangement, roller, bearing, and base

frame. The spiral lawn mower made use of multiple cutting, blade which is connected to the bevel gear is slightly raised along its rear edge to create draft that lifts the cutting blades before its cutting operation. The rotation of the cutting blade is done below the gear arrangement. As the gear arrangement rotates the reel mover tends to cut the plants or crops. The reel consists of several helix shaped blades mounted to a rotating shaft. The cutting blade used in this design is a low lift blade which is used for low speed, therefore a straight bevel gear was used due to its simplistic design and low speed. The performance of the machine was evaluated through a field test. A land predominantly covered with carpet grass was mapped out into plots of 4mx2m. Seven of these plots were selected by randomization process and mowed.

In the study of Thomas R. McCoy's solar powered golf kart, he made use of a combination of solar cells connected in an array and arranged in parallel or series connection so that a desired amount of current and voltage could be drawn. It was observed in the project study that the maximum amount of current without increasing voltage across the terminal was obtained by arranging the group of cells in the parallel connection. The array was divided into groups that included three-four cells in each. This arrangement was used mainly to charge the battery in a quick manner and this rapid charging was because of the diode which was responsible for electrical separation and that prevented the current to flow from battery to the solar cells. Every group of the solar panels had its own diode. This diode separated each group from other group of solar panels.

In the study of Anthony R. Paytas solar powered mower, the machine was designed to be operated by the electric motor. The lawnmower made use of batteries which were either charged by electric power source or by solar energy by exposing it to the sunlight insolation. In the design, the pairs of solar panels connected by the ridge of the panels was raised above the electric motor. The solar panels consisted of multiple solar cells that produced the required voltage and current. The voltage regulator at the charging outlet was connected to control

current flow with respective battery. Voltage regulator was required to maintain the safe charging as additional voltage or current could be drawn from the solar cell. The electric clutch was used as electric brake which provided the opposite polarity when the safety bar was released.

In the study of Delbert R. Lucas and Ryan J. Lucas, they developed a hybrid electric lawnmower which could be operated by either direct current (DC) or alternating current (AC) power supply. A 60 volts DC supply was provided from the battery pack to the motor with a hybrid AC/DC controller which acted as step down controller or power inverter. The full bridge rectifier was used to rectify the current from AC to DC. The mower could be run in two modes such as conserve and boost mode. An additional 6volts battery was provided to hybrid AC/DC controller that increased the speed of blade motor when switched to boost mode. Furthermore, when the mower was switched to the conserve mode, the battery life was prolonged.

In the study of Ronald Thomas and Donald H. Smiths combined A.C./DC electric lawn mower, a lawn mower was designed which had both AC and DC motors. Both motors were connected by gear and clutch arrangement which could be operated together or separately. When AC motor was powered, DC was permitted to the free wheel by the clutch assembly mechanism. When the grass was dense, both the AC and DC motors were powered. Both AC and DC motors drove the gear through their association with the clutch assembly. In the design, three gears were used which were arranged in the way that they were always in the contact with one another and the driven clutch plates were in the motion all the times. AC and DC motor were mounted adjacent to each other.

In the invention of Milshtein et al, a solar electric powered lawnmower was designed which was controlled electronically to minimize the energy consumption. Change of grass density or any other change of a load to the blade was sensed by a controller and was fed-back to the circuitry. Clean energy, low noise, no pollution, no energy cost, safe operation and low maintenance was added as benefit to the prototype to reduce its cost. Lawnmower was operated by set of batteries and solar panels. The direction of the blade could be changed so that mower could throw grass in different direction. The DC motor was selected to provide maximum efficiency of 81%-84% at the low possible current. Batteries were selected to provide high energy density (30 W- hour/kg). In this design, conventional solar cells were used with the efficiency of 14%. Solar cells were able to produce 175 watts under the normal sun condition. The machine required 24 volt and 10 amperes of current where solar cells were able to produce only 6

amperes of current.

In the study of Stephen R. Wassell, a solar powered lawn mower was designed which contained an electric motor, a rechargeable battery and photovoltaic cells panel that was attached on the handle of the lawn mower. A solar powered lawnmower was compared and studied with the gasoline powered lawnmowers from the effectiveness point of view. Both the mowers were compared and concluded that the solar powered mowers were more efficient, noiseless and had minimum energy cost. As it was solar powered, no air pollution was caused as gasoline mowers produced a lot of noise and affected the environment.

Shukitis et al, researched the methodology which solved the problem while lifting and lowering the mower deck. There was a problem with the force used to 'quick lift' of the deck. In this design, a solution was given which reduced a force of 22 pounds for lifting and lowering and for 'quick lifting', a lever system was used, that enabled the mower to lift till the maximum height.

In the study of Tony Atkins optimum blade configurations for the cutting of soft solids, the relation between the slice (blade that cuts in one rotation of the rotor) and push (the forward travel) was analyzed. It was discussed that, if the slice to push ratio was more, then the amount of grass cut was more and when the knife or blade was sharp, then more was the cutting action. In the study, the blades were arranged on helices around the cylinder and slice to push ratio was determined by the helix angle. It was also investigated that the design and ergonomics of different blades that were used in meat cutting, cylinder lawnmowers, and scythes greatly reduced the force required to cut the grass.

In the study of Johnson Alexander John's lawn mower cutting blade design, it was reviewed that in order to produce a mechanical energy, a direct current motor was used that consumed electrical energy as its input. The energy was produced due to the interaction of current carrying conductors and magnetic fields. Current or voltage was given as the input to the direct current motor and torque was the output. Self-initiated precise exchange force was utilized by the motor to control spin-waves. Sudden magnetic forces which were precisely located as well as directed were produced by the motor using the phenomena of self-initiated nonlinear magnetism.

In the study of Jean-Paul Lalonde's cutting and mulching lawn mower blades, the blade assembly for lawn mower which produced efficient mulching of the grass was reviewed. The assembly was adapted to produce self-cleaning inside the shroud housing of the mower and the internal surface of the same housing. The grass was finely mulched and blown downward outwardly of the shroud housing of the lawn mower and kept the latter clean. The grass cuttings were blown downward and it avoided the raking and reduced the need for a lateral outlet in the shroud housing. It also reduced the risks of injuries caused by obstacles which were flung outward, such as rocks, sticks, or by engagement of foot in the path of the rotating blade.

In the study of Wassell, a solar powered lawn mower was designed which was contained an electric motor, a rechargeable battery and photovoltaic cells panel that was attached on the handle of the lawn mower. A solar powered lawnmower was compared and studied with the gasoline powered lawnmowers from the effectiveness point of view. Both the mowers were compared and concluded that the solar powered mowers were more efficient, noiseless and had minimum energy cost. As it was solar powered, no air pollution was caused as gasoline mowers produced a lot of noise and affected the environment.

In the study of Willsie, a lawnmower blade was designed that had improved blade bar which was flat and also slight twist was provided. A pivotal cutter discs was fitted on each end of the blade. Each end of the blade was fitted with blower elements which blew the grass. The design provided maximum throwing of cut grass from the housing of the mower during the blade rotation. To direct the cut grass into outward direction of the cutter

discs, the blower elements were extended above the ends of the cutter discs. It facilitated the expulsion of the grassclipping beneath the lawnmower housing.

Considering, the previous work done by others in line with this project, the methodology used in carrying out this project differs from the various methods used in the above research work. In the design and construction of this project work, the proposed lawn mower is aimed at improving field cutting efficiency when compared with the conventional fossil-fuel powered lawn mower.

CHAPTER 3 Methodology

3.1 Design Consideration

Several design factors should be taken into account for the economical and efficient development of a solar lawn mower. These are considerations that should be put in place during the fabrication process so as to ensure optimal productivity of the machine. Listed below are the design consideration:

- i. The blade geometry and shape.
- ii. Materials consideration of the blade.
- iii. E.R.P. consideration.
- iv. The deck size.
- v. The power rating of the solar panel

Considering the design for the proposed lawn mower, the blade to be used is a flat shaped blade. They are generally referred to as standard blades engineered to provide enough lift to move the grass out of the mower deck area. Other blade shapes like tapered blade and sickle bar blade can also be used for the mower, but flat blade is preferred for this project because of its mass which is suitable considering the size and weight of the machine and speed of the motor. Tapered and sickle bar blades have higher cutting pressure but relatively low mass. The shaft rotating the blade has a high mass so the blade has to have a relative high mass to prevent the blade from wobbling. The material to be used for the desired flat blade is mild steel. Mild steel has strength and weight that can transmit the same speed as that of the motor which makes it suitable considering the size of the deck and shaft rotating the blade. Stainless steel and angle bar iron can also be used for the blade construction due to their durability and long-life span. But mild steel is preferred mainly because of strength and its high resistance to corrosion.

Solar energy is a time dependent energy that occurs at irregular intervals.

Therefore, energy has to be stored so it can be readily available for use when there is no further supply of the sun energy. The solar panel (or photovoltaic cell) harnesses the solar energy when the sun is available during the day. The sun produces constant amount of energy with a solar radiation intensity of about

6.33x10⁷ W/m² at the surface of the sun. Photovoltaic modules and arrays produce direct-current (DC) electricity and current combination.

3.2 Materials

Table 1.1 Materials

SR.NO.	DISCRIPTIONS	NO OF PIECES
1.	Solar Panel	1
2.	Battery	1
3.	Motor	2
4.	Blade	1
6.	Caster Wheel	2
7.	Fiber Sheet	1
8.	Switch	2
9.	Wire	meters
10.	Normal Wheel	2
11.	solar charger controller	1

1] Solar Panel

- First the solar cells are joints with the use bus bar and flux.
- Then according to use of solar panel, series and parallelconnection are given to the point
- Solar panel is used to save the electric energy. It is also usingstore the energy with the help of battery.



Figure 3.2 Solar Panel

A solar panel is a device that converts sunlight into electrical energy. It is made up of multiple photovoltaic (PV)

cells, which are connected in series and/or parallel to increase the output voltage and current. The PV cells are made of semiconductor materials, such as silicon, that absorb photons from the sunlight and release electrons, creating a flow of electrical current. The solar panel also includes a protective cover, frame, junction box, and wiring to connect to other components or devices. The size and power output of a solar panel depend on the number and type of PV cells used, as well as the efficiency and temperature performance of the panel.

2] Battery



Figure 3.3 Battery

Solar power can be stored in the rechargeable battery and can be further used for the grass cutting machine to run. A 12v battery is a type of rechargeable battery that

has a nominal voltage of 12 volts. These batteries are commonly used in vehicles, such as cars, boats, and RVs, as well as in off-grid solar systems to store energy generated by solar panels. 12v batteries come in different types, including lead-acid, lithium-ion, and nickel-cadmium. Lead-acid batteries are the most common type of 12v battery and are relatively inexpensive, but they require regular maintenance and have a shorter lifespan than other types. Lithium-ion batteries are more expensive but have a longer lifespan and require less maintenance. Nickel-cadmium batteries are less common and are mainly used in industrial applications.

1. Versatility: 12v batteries are versatile and can be used in a variety of applications, including vehicles, solar systems, and backup power supplies.
2. Reliability: 12v batteries are reliable and provide consistent power output, making them ideal for powering essential equipment and appliances.
3. Portability: 12v batteries are compact and lightweight, making them easy to transport and install in different locations.
4. Rechargeable: 12v batteries are rechargeable, which means they can be used multiple times and do not need to be replaced frequently.
5. Cost-effective: 12v batteries are relatively affordable compared to other types of batteries, making them an economical choice for many applications.
6. Low self-discharge rate: 12v batteries have a low self-discharge rate, which means they can hold

their charge for a long time without needing to be recharged.

7. Maintenance-free options: Some types of 12v batteries, such as lithium-ion batteries, require little to no maintenance, making them a convenient option for many users.

3] Motors



Figure 3.4 Motor

This motor is used for the rotating the blade and when the blade is rotated the grass is cut. The motor is rotated at 2000 RPM.

The motor is also used to rotate the wheel which move the body.

1. Efficiency: DC motors are highly efficient, converting electrical energy into mechanical energy with minimal energy loss.
2. Speed control: DC motors can be easily controlled for speed and torque, making them ideal for applications that require precise control.
3. Low maintenance: DC motors have a simple design and require little maintenance, reducing the need for costly repairs and downtime.
4. Compact size: DC motors are compact and lightweight, making them suitable for use in small spaces or applications where weight is a concern.
5. Durability: DC motors are built to last, with rugged construction and high-quality materials that can withstand harsh environments and heavy use.
6. Low noise: DC motors operate quietly, making them ideal for applications where noise is a concern, such as in medical equipment or home appliances.
7. Compatibility: DC motors can be used with a variety of power sources, including batteries, solar panels, and AC power supplies, making them versatile and adaptable to different applications.

4] BLADE



Figure 3.5 Blade

We have used the homemade blade. In which there are four wings

In a solar grass cutter, the cutting blade is typically made of steel or a steel alloy. The blade size and shape will depend on the specific model of grass cutter, but it is typically a circular blade with a diameter of 8-12 inches. The cutting edge is usually sharpened to a medium degree, providing a balance between clean cuts and durability. The blade thickness is also important, as it must be strong enough to cut through thick grass and weeds without bending or breaking. Some solar grass cutters may have a coating on the blade to improve its performance and durability. The arbor size will also vary depending on the specific grass cutter model. Safety features such as guards and anti-kickback mechanisms may also be included to prevent injury during use.

5]. Caster wheel.



Figure 3.6 Caster wheel

We used the caster wheel for moving the body

caster wheel is used to move high load object. With the help of caster body move easily.

A caster is an assembly that includes a wheel and a mount. Casters support and make it easy to maneuver carts, racks, dollies and other equipment. Casters come in different materials, wheel diameters, tread widths, load ratings and overall heights to give your equipment mobility in many kinds of work environment.

Caster causes a wheel to align with the direction of travel, and can be accomplished either by caster displacement or caster angle. Caster displacement moves the steering axis ahead of the axis of wheel rotation, as with the front wheels of a shopping cart. Caster angle moves the steering axis from vertical.

6] Fiber Sheet

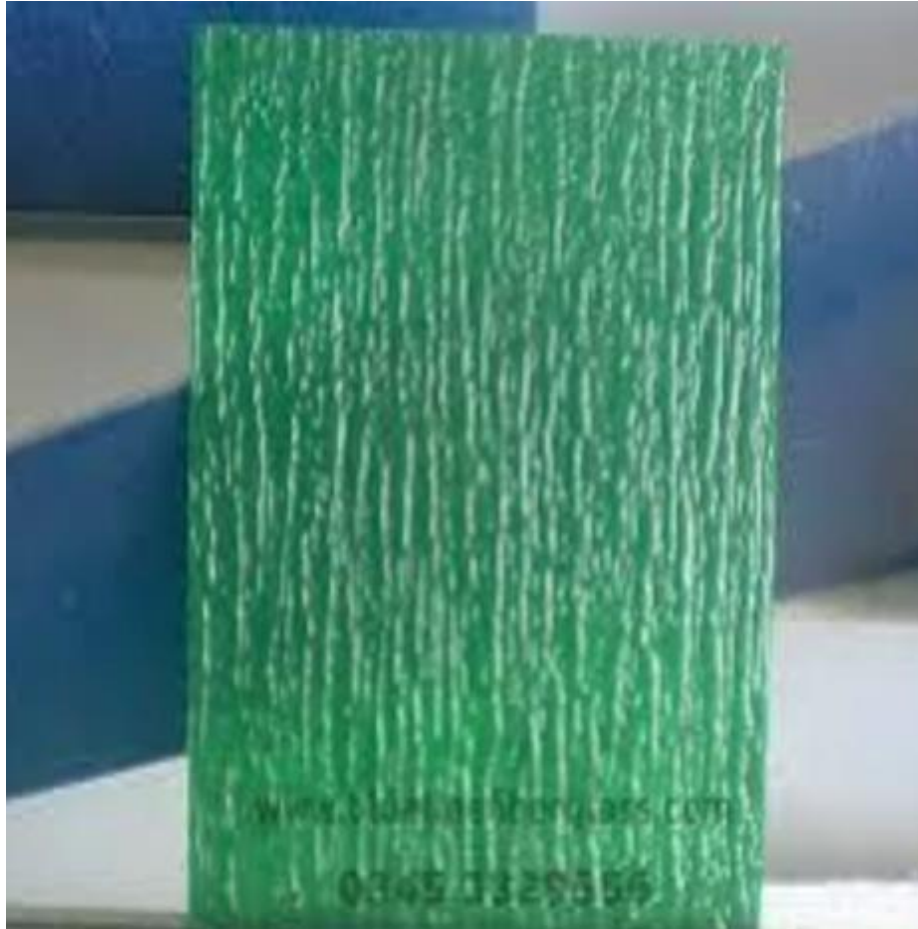


Figure 3.7 Fiber Sheet

We have used the fiber to cover the body of the project. And we have used to kept the solar panel.

Fiber sheet means any natural or synthetic substance composed of thread-like materials interwoven, pressed or molded into a thin sheet-like form.

The average price of fiber sheets in India is between Rs 150 and Rs 600 per sq. ft. Its strength makes it ideal for kitchen utensils and furniture elements. Carbon fibersheets are commonly used for making picture frames and light fixtures. The material has a unique look compared to other materials. It gives a modern, futuristic feel to rooms, without the harshness metal or glass brings.

7] Switch



Figure 3.8 Switch

We have used to the ON OFF the blade. And for the circuit to do ON & OFF.

the bipolar switch has the positions open and closed, while the push-button can be NO, normally open, or NC, normally closed in the case of the on-off switch, the button with the I/O marking is used to switch on or off any equipment permanently, until a new command is given. Specifically, the bipolar switch has the positions open and closed, while the push-button can be NO, normally open, or NC, normally closed.

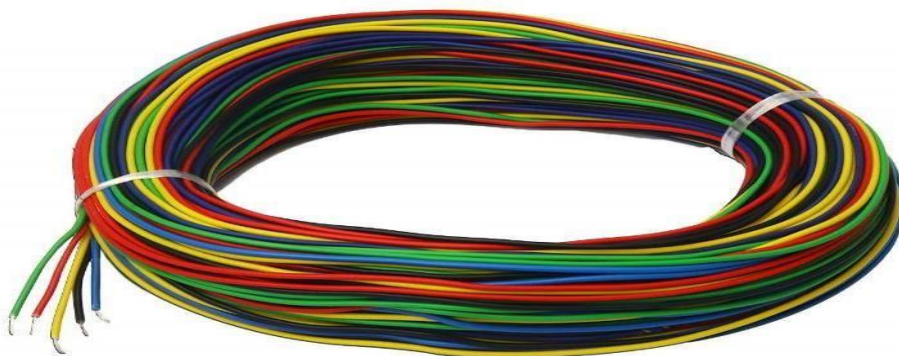


Figure 3.9 Wire

8] Wire

We have used the wire for giving different connection in motor,circuit, transistor, etc.

An electrical wire is a type of -conductor, which is a material that conducts electricity. In the case of household wiring, the conductor itself is usually copper or aluminum (or copper-sheathed aluminum) and is either a solid metal conductor or stranded wire.

Most wires in a home are insulated, meaning they are wrapped in a nonconductive plastic coating. One notable exception is ground wires, which are typically solid copper and are either insulated with green sheathing or uninsulated (bare).

9] Normal wheel



Figure 3.10 Normal wheel

It is used for giving feed to the front wheel. The motors relate to these two wheels.

Wheels, in conjunction with axles, allow heavy objects to be moved easily facilitating movement or transportation while supporting a load, or performing labor in machines. Wheels are also used for other purposes, such as a ship's wheel, steering wheel, potter's wheel, and flywheel

Wheel or rim diameter is the distance measured in inches across the face of the wheel, from bead seat to bead seat. It's measured this way because that's where the tire and the wheel come together. In our example, the diameter is 16 inches.

10] Solar charger controller



Figure 3.11 solar charger controller

A charge controller, charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries to protect against electrical overload, overcharging, and may protect against overvoltage. This prevents conditions that reduce battery performance or lifespan and may pose a safety risk. It may also prevent completely draining ("deep discharging") a battery, or perform controlled discharges, depending on the battery technology, to protect battery life. The terms "charge controller" or "charge regulator" may refer to either a stand-alone device, or to control circuitry integrated within a battery pack, battery-powered device, or battery charger.

3.2 Experimentation

The 10 watts' solar panel is used to charge the batteries which are rechargeable. the solar panel gives maximum 18v and 580mA current. we need charging circuit between solar panel and batteries. The charging circuit has voltage regulator which regulates voltage to 15v and one transistor to amplify the maximum current to circuit and diode is used. we use 12 voltage battery for entire circuit and another 12v volts for cutting blade. The microcontroller 8051 takes the input from the ultrasonic sensors, when any interrupt or obstacle occurs the ultrasonic sensor senses the obstacle and gives feedback to microcontroller then according to the program which was given to microcontroller its turns left or right. It waits up to some delay and senses again and same procedure works if no detection occurs to ultra-sonic range, then it moves forward until it finds some detection. B The movement of bot is done by using the two DC motors of 100 rpm.

The motors are driven by using motor driver (L293D). It is also known as H- Bridge. The main purpose of using motor driver is because that DC motors require the minimum voltage as 9v as input. But the microcontroller gives output as only 5v so we require 9v to 12v for driving the motors. So, we use motor driver which takes 5v as input and gives the 12v for motors. The L293D motor driver drives only two motors which can move in both directions. And the cutting blade is used to cut the grass to cut any type grass we need high rpm motor, so we used 1400 rpm motor for cutting blade. The motors run directly by 12v rechargeable battery. The DPDT switches are used for movement of bot and cutting blade separately.

1] Dimensions for the Blade

Length = L = 400 mm Breadth = 30mm Thickness = T = 4 mm

speed of motor = N = 3000 rpm Density = $\rho = 7850 \text{ kg/m}^3$

Acceleration due to gravity = $g = 9.81 \text{ ms}^{-2}$

i. To determine the area of the blade

area of the blade = length * breadth
area of the blade = $L * B$

area of the blade = $400 \text{ mm} * 30 \text{ mm} = 12000 \text{ mm}^2$

ii. To determine the volume of the blade

volume of the blade = area of the blade * thickness
volume of the blade = $12000 \text{ mm}^2 * 4 \text{ mm} = 48000 \text{ mm}^3$

iii. To determine the mass of the blade

mass = density * volume

= $7850 \text{ kg m}^{-3} * 4.8 * 10^{-5} \text{ m}^3$

= 0.377 kg

iv. To determine the weight of the blade

weight of the blade = mass of the blade * acc due to gravity

= $0.377 \text{ kg} * 9.81 \text{ ms}^{-2} = 3.7 \text{ N}$

v. To determine the torque

radius of the blade = diameter / 2

= $400 \text{ mm} / 2$

= 200 mm

= 0.2 m

Torque = weight of the blade * radius of the blade
Torque = $3.7 \text{ N} * 0.2 \text{ m}$

Torque = 0.74 Nm

vi. To determine the angular velocity

$\omega = 2\pi N / 60$

where $N = 3000$ $\pi = 3.142$

$\omega = 2 * 3.142 * 3000 / 60$

= $18852 / 60$

= 314.2 rad/s

vii. To determine the power generated at the blade

power generated at the blade = Torque * angular velocity

= $0.74 \text{ Nm} * 314.2 \text{ rad/s}$

= $232.28 \text{ W} = 0.23 \text{ KW}$

viii. To convert Kilowatt to Horsepower

since 1 KW is equivalent to 1.341 metric HP

therefore,

0.23 KW is equivalent to 0.3 Hp

For design purpose 1Hp will be used for this project, so that it provides the required torque in order to cut all types of grass effectively.

Hence, the centrifugal force according to Kurmi and Gupta (2000) $F_c = m\omega^2 r$

Hence, $F_c = 3.7 \times 314.2 \times 0.2$

= 73.0 kN

Working process

Intelligent information appliance is the main direction of development in the appliance control at irrigation fields. We designed a broad and commendable range of Solar Grass Cutter along with solar panel. As the energy conversation is very important in the current scenario and should be done to a maximum extent wherever it is possible. Still, these mowers grass cutting machineries all need the same things to work right a motor, a rotating blade, a means of getting around and a way to get rid of the grass clippings.

The controlling device of the whole system is provided using switch ON the DC motor interfaced with grass cutting blades. The entire model consists of two sections one controlling section and another designing section of the model. The

controlling section consists of Rechargeable battery, relays switches and Solar panel. The system depending on the charging circuit the motor can be controlled using relay switch. The solar power stores the energy to a battery and then runs the motor through the relay switch.

- Coming to the working of solar powered grass cutter, it has panels mounted in a particular arrangement at an angle of 45 degrees in such a way that it can receive solar radiation with high intensity easily from the sun.
- These solar panels convert solar energy into electrical energy as studied earlier. Now this electrical energy is stored in batteries by using a solar charger.
- The main function of the solar charger is to increase the current from the panels while batteries are charging, it also disconnects the solar panels from the batteries when they are fully charged and also connects to the panels when the charging in batteries is low.
- The motor is connected to the batteries through connecting wires. Between these a two-motor driver is provided. It starts and stops the working of the motor.
- From this motor, the power transmits to the mechanism and this makes the blade to rotate with high speed and this makes to cut the grass.

Design:

In designing the cutting blade, the force required to cut the lawn as well as the force acting on the blade was considered. The force required by any sharp object to have impact on the grass is less than 10 Newton. It is

also dependent on the height, density and the area covered by the object (Atkins, 1984). Therefore, in designing the blade of the solar powered lawn mower, the force required for effective mowing should be greater than 10 Newton. A stainless steel was used in the construction of the cutting blade because of its strength and weight which can transmit same speed as that of the DC motor or a little less cause of friction.

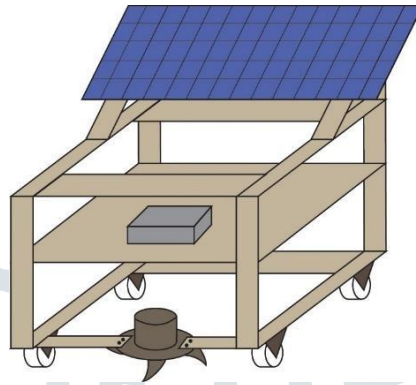


Figure 3.12 SolidWorks model of grass cutter

3.3 Observations

This project's objective is to design and develop a solar grass cutter that runs on solar energy and avoids the drawbacks of traditional lawn cutters. The goal is to prevent a power outage in India while also reducing human labor, walking value, and preservation costs. Furthermore, the use of a solar-powered completely lawn cutter assists to take care of the environment and healthy. It has long been used to control a variety of grasses for a variety of purposes. The full version is powered by solar energy collected in the batteries. The Ultra-Sonic sensor will detect obstacles in order to protect humans, objects, and animals. A relay has also been used to operate the motor that drives the blades and wheels.

Table 3.2 Materials Cost

S.R.NO	DISCRIPTIONS	PRICE
1.	Solar Panel	000
2.	Battery	000
3.	Motor	00
4.	Blade	00
6.	Solar charger controller	450
7.	Caster wheel	400

8.	Fiber Sheet	100
9.	Switch	10
10.	Wire	40
	TOTAL	5000

Chapter 4

Result

4.1 Instruction for Operating the System

1. Charge the battery: Before using the solar grass cutter, make sure to fully charge the battery using the provided charger.
2. Set up the boundary: Use the boundary wire to mark the perimeter of your lawn. This will help the solar grass cutter stay within the designated area.
3. Turn on the device: Turn on the solar grass cutter by pressing the power button.
4. Set the cutting height: Adjust the cutting height according to your preference using the height adjustment knob.
5. Set the mowing schedule: You can set a specific schedule for the solar grass cutter to mow your lawn automatically. This can be done using the control panel or through a mobile app.
6. Monitor the device: Keep an eye on the solar grass cutter while it is in operation to ensure that it is working properly and not encountering any obstacles.
7. Clean and maintain the device: After use, clean the device and remove any debris that may have accumulated on the blades. Regular maintenance will ensure that the solar grass cutter remains in good condition and lasts longer.

4.2 Results

The solar powered lawnmower was fabricated and tested. During the machine operation electrical energy of the battery was converted to mechanical energy through the blade to achieve cutting operation. The electric circuit ensured that power was transferred from the battery to run the DC motor, while the solar panel continuously charged the battery during operation. The blade generated power from the DC motor at a speed of 3000rpm. When the switch is on, the electrical energy from the battery powers the motor which in turn actuates the blade. The solar panel generates current to recharge the battery, thereby compensating for battery discharge. The rotating blade continuously cuts the grass as the mower is being propelled. During the operation it was convenient to cut grasses at different height using an adjustable lever mechanism attached to the to the deck area of the machine.

4.3 Performance analysis Testing

This chapter deals with after completion of the design and fabrication work, different laboratory and field tests were conducted to evaluate the performance of the solar grass cutter and the procedures followed are presented in this chapter.

Performance evaluation of the developed solar grass cutter Field test

The performance of the machine was evaluated through a field test. A land predominantly covered with Stubborn grass and spare grass was mapped out into plots of 20 mx50 m. three of these plots were selected by randomization process and mowed. The solar grass cutter uses cutting blade arranged in form of a horizontally which is turned by D.C.motor. The act of pushing switch, machine makes the blade revolve. The theoretical field capacity (FCt), Effective field capacity (FCe), and Field efficiency (η) were computed with equations.

Theoretical field capacity (FCt)

Theoretical field capacity FCt = forward speed x theoretical width $FCt = V_s \times W$

Effective field capacity (FCe)

Effective Field capacity (FCe) = Actual area cover / Total time taken $FCe = A/t$

Field efficiency (η)

$\eta = \text{Effective Field capacity} / \text{Theoretical field capacity} \times 100\%$

$= FCt / FCe \times 100\%$

Field capacity

The field capacity was also determined by using $C = \text{Theoretical field capacity} \times \eta$

Calculation of current and charging time of the battery Measurement of Current from panel

The current (I) produced by the solar panel and calculated by knowing the maximum power (P) of the solar panel and the voltage rating (V) of the battery that is given by $I=P/V$

Determination of Charging time (T)

Charging time was computed by taking the ratio rating of battery in ampere hour (Ah) to the total current consumed by the solar panel. $T = (\text{battery rating in amperehour}) / (\text{total current consumed by the solar panel})$

Practical measurement of current and charging time of the battery Experimentally the current produced by solar panel can be measured by connecting an ammeter in series with supply. The charging time of the battery using solar panel has been measured by continuously charging battery.

Field capacity

The performance of the solar grass cutter is presented in Table 1, indicating the value of computed effective field capacity and field efficiency. The average effective field capacity is obtained as 468.62 m² /hr and Field efficiency (%) as 66%(approx.), with operating time of 1 hr. The theoretical field capacity (FCt) of the machine was calculated to be 700 m² /hr with average forward speed of 2 km/hr and the theoretical width of .35m. The field capacity of the proposed system is given by the mathematical calculation in appendix A-1. For

determination of the actual field capacity its need some necessary to collect some field data which given by the table 2. The machine was seen to be more effective when working in a dry soil condition, because there is proper gripping of the tyres in a dry conditionof the soil.

4.4 Photograph of setup

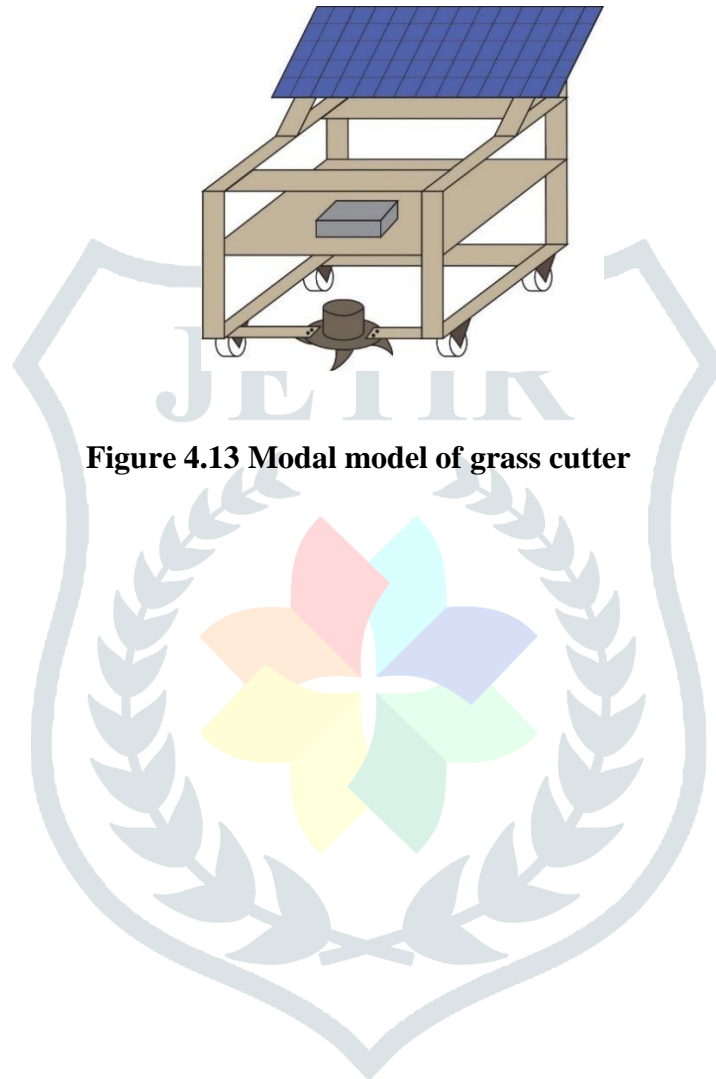


Figure 4.13 Modal model of grass cutter

5.1 Conclusion

5.2 Chapter 5

Conclusion

The solar grass cutter designed, fabricated and tested and the results obtained are satisfactory. This does have engine and the operator is by powered. It will be easier for the people who are going to take the project for the further modifications. This project is more suitable for a common man as it is having much more advantages i.e., no fuel cost, no pollution and no fuel residue, less wear and tear because of a smaller number of moving components and this can be operated by using solar energy. At present in order to curtail global warming and ozone depletion, the Government of India is offering subsidy for the solar equipment's.

The industries are producing these components in mass productions, so the cost of the system may come down. So, in future it is expected to run all equipment's by using solar energy. This system is having facility of charging the batteries while the solar powered grass cutter is in motion. So, it is much more suitable for grass cutting also. The same thing can be operated in night time also, as there is a facility to charge these batteries in day light. In the world today, all machines are designed with the aim of reducing or eliminating greenhouse gas emissions which is the major causes of climate change. This solar powered lawn mower will meet the challenge of environmental production and low cost of operation since there is no cost for fueling. A solar powered lawn mower has been developed for the use of residences and establishments that have lawns where tractor driven mowers couldnot be used.

5.3 Future Scope

In conclusion, solar grass cutters have immense potential in the future due to their environmentally friendly and cost-effective nature. They offer increased efficiency, versatility, improved safety, and smart technology integration, making them a viable alternative to traditional gasoline-powered mowers. As the world moves towards sustainable practices, solar grass cutters could play a significant role in reducing carbon emissions and promoting a cleaner environment.

We completed our project successfully with the available sources. But the results and modifications are not up to the expectations. This can be further improved by incorporating the following modifications to obtain better results. The mechanism

which we used does not given excepted efficiency. This efficiency can be increased by using some other mechanism. The work can be further improved by making the handle adjustable so that people of different height can easily use this grass cutter. Even the height of the blade can be made adjustable so that the depth of cutting height can be decided before cutting the grass. In its advance form it can be made automatic with the help of sensors and advance controllers.

References

- 1] Ali Reja Osmani. Conventional Energy to Renewable Energy: Perspectives for India ISSN. 0972 - 8406 41 The NEHU Journal. 2014; XII (2):41-60
- 2] Robert Zondlo, U.S. Patent 5,461,292, Remote controlled guidance system for working vehicle, October 24, 1995.
- 3] Ahamad, 2008. Feasibility Study on Design of Grass Removing Machine, Melaka: University of Technical Malaysia.
- 4] Bidgar, P. et al., 2017. Design and Implementation of Automatic Solar Grass Cutter. International journal of advanced research in electrical, electronics and instrumentation engineering, 6(4), p. 2433.
- 5] K, V., K, P., R, S. & A, S., 2015. Fabrication and Analysis of Lawn Mower. International Journal of Innovative Research in Science, Engineering and Technology, 4(6), p. 606
- 6] M, S. M. & Ahmad, P. K., 2018. Design and fabrication of two-wheeler operated sickle bar mower. International Research Journal of Engineering and Technology, 05(10), p. 530.
- 7] P, B. et al., 2017. Design and Implementation of Automatic Solar Grass Cutter. International journal of advanced research in electrical, electronics and instrumentation engineering, 6(4), p. 2433.
- 8] Satwik, D. & Ramalingeswara, 2015. Design and Fabrication of lever operated Solar Lawn Mower and Contact Stress analysis of Spur Gears. International journal of Science, Engineering and Technology Research, 4(8).
- 9] Singh, M. et al., 2016. A review and comparative analysis of solar, electric and gasoline lawn mowers: An extensive study. International journal of innovative science, engineering and technology, 3(4), pp. 371-375.
- 10] Tanimola, Diabana & Bankole, 2014. Design and development of a solar powered lawn mower. international journal of scientific & engineering research, 5(6), pp. 216-217.
- 11] Venkatesh, K., Priyanka, K., Sridhar, R. & Sakthivel, A., 2015. Fabrication and Analysis of Lawn Mower. Interational Journal of Innovative Research in Science, Engineering and Technology, 4(6), p. 606.
- 12] Satwik, D. & Ramalingeswara, 2015. Design and Fabrication of lever operated Solar Lawn Mower and Contact Stress analysis of Spur Gears. International journal of Science, Engineering and Technology Research, 4(8).
- 13] P, B. et al., 2017. Design and Implementation of Automatic Solar Grass Cutter. International

journal of advanced research in electrical, electronics and instrumentation engineering, 6(4), p. 2433.

- 14] Ogiemudia, O., 2016. Design and Improvement of a Solar Powered Lawn Mower from Locally Sourced Material. ELK Asia Pacific Journals, 2(1), p. 1.
- 15] M, S. M. & Ahmad, P. K., 2018. Design and fabrication of two-wheeler operated sickle bar mower. International Research Journal of Engineering and Technology, 05(10), p. 530.
- 16] Mohammad, M. S., Ahmad & Prof, 2018. Design and fabrication of two- wheeler operated sickle bar mower. International Research Journal of Engineering and Technology, 05(10), p. 530.
- 17] Bulski, P., Yu, S. and E.D., D. (2008) 'Investigation of sound induced by grass cutting blades. Journal of Engineering and applied science ,3, pp.290-298.
- 18] Yogita D. Ambekar, Abhishek U. Ghate, "Solar Based Grass Cutter", Second International Conference on latest trend in engineering, science, humanities and management, Page no. 322-326, Feb-2017.
- 19] Praful P. Ulhe, Manish D. Inwate, Fried D. Wankhede and Krushankumar S. Dhakle, Modification of Solar Grass Cutting Machine, International Journal for Innovative Research in Science and Technology, Vol.2,2016,2349-6010.
- 20] Sujendran S. and Vanitha p., Smart Lawn Mower for Grass Trimming, International Journal of Science and Research, Vol.3, 2014, 2319-7064.

