

# Grass Cutter Machine

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**Abstract** – In current days, grass cutter machines are operated by fuel and electrical energy which are costly and requires high maintenance. Hence, in this study, a hand-held operated machine for grass cutting was designed and fabricated by using locally available materials. Important aspects such as durability, strength, and light weight were taken into design considerations for better performance characteristics. The lawn mower was powered by a 12V/1.35A rechargeable battery which drives the DC motor up to a rotational speed of 19,300 RPM. As a result, the generated torque will be transferred to the cutting head mechanism for efficient grass cutting. The entire configuration set up was mounted on a wooden base which attached together with a bicycle frame and a set of wheel arrangement. This portable lawn mower can be used to maintain and trim grass in gardens, home, schools or yards.

**Keywords** – grass cutter, bicycle frame, lawn mower, hand-held, battery, portable.

## I. INTRODUCTION

Grass cutter machines have become very essential to our daily living in maintaining the yards. Furthermore, environmental awareness on usage of grass cutting machines has caught a great interest among consumers. As a result, consumers are searching for ways to reduce and solve their own carbon footprints. Moreover, environmental pollution keeps increasing and it can be experienced in our daily life, particularly in our homes. Based on a study, it is reported that 70% of Malaysian home citizens are utilizing fuel powered lawn mowers for their daily grass cutting routine.

Thus, high maintenance is needed in order to maintain a lawn mower. For instance, one should change the fuel or oil regularly so that the lawn mower works efficiently during the process of grass cutting. Furthermore, this will incur extra variable cost since the fuel price has been increased lately. In order to overcome these issues, an eco-friendly lawn mower needs to be designed and fabricated in order to support the green technology initiatives. In this study, a newly designed lawn mower was fabricated which powered through a rechargeable battery. Besides that, the grass cutting machine was fabricated at low cost by taking consideration on important aspects such as lightweight, durable, and environmental friendly.

A lawn mower is a machine that uses cutting blades or strings which is used to cut the grass in gardens or yards at an even length. The working principle of the lawn mower is to provide a high speed rotation to the blades, which aids in cutting the grass through generated kinetic energy. The main parts of this prototype lawn mower consist of a DC motor, a pulse width modulation (PWM) device

for controlling the motor, bicycle frame and wheels as the body structure, and a rechargeable battery. For safety operation, the motor will be controlled by a PWM device as since the motor has a high rotational speed of 19,300 RPM. As for the cutting head, nylon strings will be used as the trimmer instead of traditional cutting blades due to cost effectiveness, safety, and flexibility. Besides that, since the motor delivers a minimum torque value, hence nylon strings are much more suitable since it is lighter in weight [3].

With reference to current literature availability, there are many variations of lawn mowers that exist in the global markets, which may not fulfil the performance and operational cost criteria.

## II. METHODOLOGY AND DESIGN ANALYSIS

Overall Design of the Lawn Mower Body Structure Before the actual fabrication process was carried out, the lawn mower was designed and simulated using Autodesk Inventor Professional 2016 software which is shown in Figure-1. The body structure of the lawn mower had three main components which were the bicycle handle, the wheels and the base. The handle and the wheels will be used as the navigation panel to control the lawn mower while the base acts as the support where the motor and the battery will be attached to it.

There are few advantages of this newly designed lawn mower. Firstly, the mower has two wheels which allows the user to maneuver the mower freely. Moreover, the weight of the lawn mower will be supported by the training wheels and hence less effort or workforce is required by the user. Besides that, since the cutting head

will be installed in front of the base, therefore the lawn mower will be able to operate around acute areas such as trees or fences.

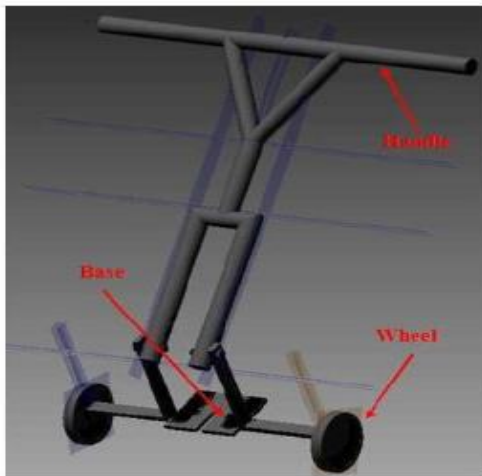


Fig-1: Body structure of the lawn mower

With this simple design concept, the weight of the lawn mower can be reduced immensely. The lawn mower was designed in an ergonomic approach where the structure can be adjusted with the help of adjustable screws as shown in Figure-2. Moreover, this enables the user to adjust the height or the angle based on his/her preference.

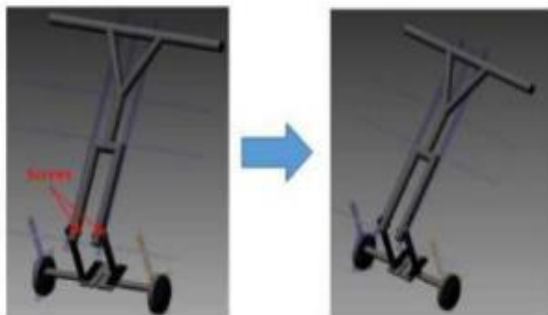


Fig-2: Height and angle adjustment for the lawn mower

### 1. Material Selection for the Base

There are few materials such as wood, aluminum, mild steel or composite were considered beforehand for the mower base.

### 2. Selection of Electric Motor

Selecting a suitable electric motor is one of the important criteria in designing a lawn mower since the motor is the one that drives the generated torque to the cutting head to trim the grass. Moreover, the size of the motor shall be small enough so that it will fit. Thus, a Banebots RS-550 DC motor was chosen since it satisfied those minimum requirements. Table-1 shows the specification of the DC motor.

Table-1: Motor specification [8]

Specification	Banebots RS-550 DC
Operating Voltage (V)	6-14.4 (12V nominal)
Angular speed, (RPM)	19,300
Load Current (A)	1.3
Stall Current (A)	85
Stall Torque (mN.M)	498.2
Weight (kg)	0.218
Shaft diameter (mm)	3.2
Shaft Length (mm)	7.6

### 3. Selection of Battery

For the rechargeable battery, GPP1245 lead acid battery was chosen due to its long lasting performance. Moreover, the battery was found to be compatible with the DC motor compared to other variation of batteries. Table-2 shows the specification of the battery.

Table-2: Battery specification [8]

Specification	GPP1245 Lead Acid Battery
Operating Voltage (V)	12
Ampere Hour, (Ah)	4.5
Load Current (A)	1.35

### 4. Design of the Cutting Head

For the lawn mower cutting head, nylon strings were used instead of traditional cutting blades since it is flexible, affordable, lighter and easily replaceable. Besides that, since the stall torque generated by the motor has a minimal output value (Table-1), therefore usage of strings would provide an optimum result. The string trimmer is also able to operate in acute areas due to its flexibility in nature.



Fig-4: Bicycle frame (left) and wheel (right)



Fig-5: Mounting the training wheels to the bicycle frame



Fig-6: Attaching the base to the bicycle frame



Fig-7: Crafting wiring pathway for the electrical components



Fig-8: Attaching the soldered electric motor to the base

### 5. Pulse Width Modulation Device

Pulse width modulation (PWM) device was used and attached together to the lawn mower mainboard. Since the motor has a high rotational speed of 19,300 RPM, therefore this device will help to control the speed in order to prevent any mishap. Moreover, it is able to withstand maximum load current and voltage of 3A and 12V respectively. The speed of the motor can be easily manipulated by controlling the switch which is shown in Figure-3

## III. PROJECT GOALS AND OBJECTIVES

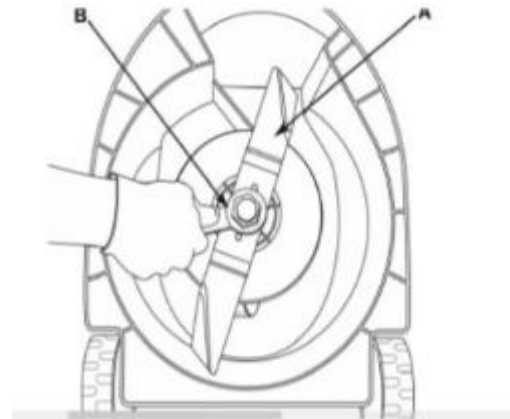
In keeping with the motivation behind the project, the goal of this project was to reduce end-user work through the utilization of an easy-to-use device. The autonomous design eliminates the need to go outside and mow your lawn every week. The project was initially designed to learn your yard in one initial session and then repeat the process indefinitely as needed.

In our initial design, once the boundaries have been established, the user simply needs to program the mowing schedule, via a control panel on the mower chassis itself or wirelessly through some other interactive platform (i.e. smart phone, PC, etc.). However, the mowing scheduling was not implemented because of limited time and it would complicate the design. For prototyping, a standard laptop was used by the computer vision camera to simplify the overall design. Additional ideas that were not implemented in the final design included the mower executing its cutting routine in accordance with this

schedule and returning to its charging station upon completion of its task or when the onboard batteries have reached critically low levels. In addition, a precipitation sensor would be implemented to monitor the amount of precipitation in the area. If the threshold values are exceeded, the mower would return to its sheltered charging station to protect its electrical components from water damage.

## IV. METHODOLOGY

Methodology is the systematic, Theoretical analysis of the methods applied to a study or to the theoretical analysis of the method and principles associated with branch of study. 1. Studying the present mechanisms. 2. Field Survey 3. To identifying the potential problem. 4. Problem definition. 5. Literature review. 6. Design of grass cutter. 7. Calculation. 8. Analysis using FEM method. 9. Fabrication.



(Fig. 11)

Assembling the Blade with the Electric Motor's Shaft

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### 1. LM358 comparator:

In the proposed fabricated model we use a comparator for controlling the relay switch of the motor when the user switches the supply unit. Also, it compares the temperature of the motor and when it exceeds beyond the threshold limit, it switches off the motor and protects from over heat in its continuous usage.

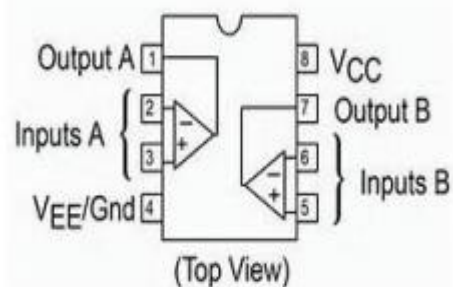


Fig.3 Image of LM358 comparator

## 2. Battery:

Solar power can be stored in the rechargeable battery and can be further used for the grass cutting machine to run.

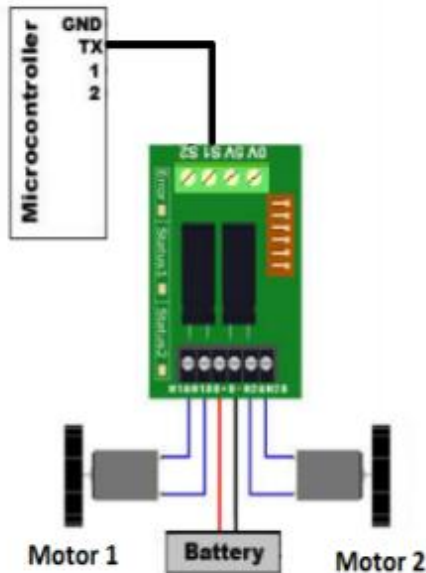


Fig 4. Rechargeable battery

## 3. Relay:

A relay is an electrically operated switch. We use it in the grass cutting machine model for controlling the motor connected to blades as a switch. Many relays use an electromagnet to operate a switching mechanism, but other operating principles are also used. Relays find applications where it is necessary to control a circuit by a low-power signal, or where several circuits must be controlled by one signal.

## 4. Temperature Sensor:

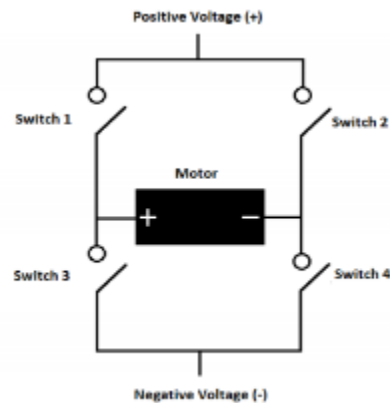
The device solar grass cutting machine uses temperature sensor for providing the safe guard for the motor.



Fig.5. Temperature Sensor

## 5. Motor:

In the presented idea for grass cutter model we used Johnson DC motor interfaced with blades for cutting grass when operated. A dc motor uses electrical energy to produce mechanical energy, very typically through the interaction of magnetic fields and current-carrying conductors. sudden magnetic forces, using selfinitiated nonlinear magnetic phenomena.



## 6. Grass Cutter Blade Analysis in Ansys:

A static structural analysis determines the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects.

## V. RESULTS FOR GRASS CUTTER BLADE IN STRUCTURAL ANALYSIS

Analysis of grass cutting blade is done in ANSYS software, from these analyses following maximum and minimum equivalent elastic strain, equivalent elastic stress and total deformation

### 1. Blade –

Consist of blades that are attached to a vertically rotating shaft, to the downward direction. The blades rotate, creating a cutting motion.(fig. 6) A High-Carbon Steel Cutting Blade It's important to cut lawn, with a sharp blade as blunt blades can rip or tear grass from the roots, damaging our greenery and causing our lawn to become

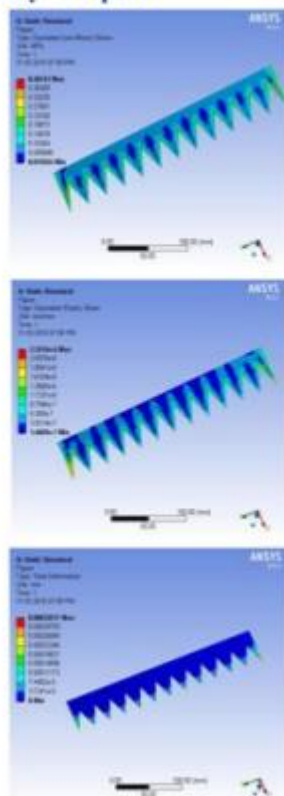
patchy over time. Size: - 13 inches, Metal: - The blade is made of Steel.



(Fig. 6)

A High-Carbon Steel Cutting Blade

Table 6.3: Analysis report



## 2. Body frame –

The main structural frame of the mower onto which the other parts of the mower are mounted.

## 3. Wheels –

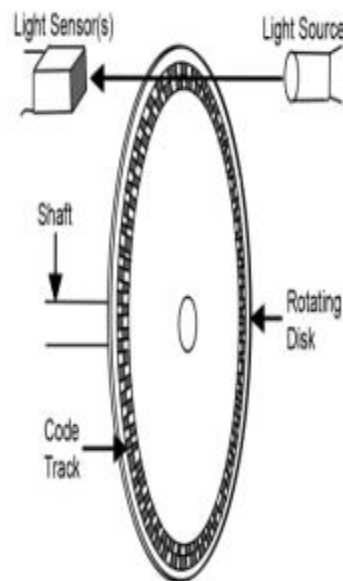
These help propel the mower in action. Generally, our lawn mowers have four wheels. The diameter of the wheel is 8 inches.(Fig. 7) A Base Frame with Four

Wheels of the Lawn Mower The wheels having rubber gripped, for better moving on grass. We are using wooden wheels for reducing the cost of lawn mower. 3.1.4 Push handle - The "power source" of a manually operated mower. (Fig.8) .This is a sturdy U-shaped handle that is connected to the frame, wheels and blade chamber. The length of push handle is 36 inches. (Fig 8) A push Handle of the Lawn Mower The hollow Iron piped push handle will be designed to provide adequate sectioning for the separate subsystems.



(Fig. 7)

A Base Frame with Four Wheels of the Lawn Mower



## VI. STUDYING THE PRESENT MECHANISMS.

Background A) Agricultural farm Machinery and Equipment: Manual labour takes time and is not effective as they can work for 3 to 4 hours at a stretch. Even if the land holding is small, it takes two or three day completely harvests the soybean grass. Also the planting is not done with proper care. The machine focus the project is to make combination of harvesting and collecting machine for the small scale farmers in India who have land holding less than two acres, to harvest grain more efficiently.

### 1. Design of Grass Cutter.

In this project the idea is to make the mechanization of small scale grass cutting machine. The machine focuses to combination of cutting and collecting the grass for small scale farmers. Different parts of a machine will be mounted on strong chassis. The wheel will be attached to this chassis.



Figure 1. Our Model of the grass cutter [7].

### 4. Related Work:

Intelligent information appliance is the main direction of development in the appliance control at irrigation fields. We designed a broad and commendable range of Super Mini Electric 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 where ever 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.

#### Advantages:

1. They have no moving parts and hence require little maintenance and work quite satisfactorily without any focusing device.
2. It does not cause any environmental pollution like the fossil fuels and nuclear power.
3. Solar cells last a longer time and have low running costs.
4. Low power consumption.
5. Conservation of energy.
6. Utilization of free available source of energy from sun
7. Storage of energy into rechargeable battery.
8. Stored energy is used for grass cutter.

## VII. RESULTS

The area of cut (battery duration) depends on lawn conditions, grass density, moisture content, grass length and height of cut. 2) Switching the product on and off frequently during cutting will also reduce the area of cut (battery duration). 3) To improve the area of cut (battery duration) it is recommended to cut more frequently, raise the cutting height and walk at a normal pace. 4) The

maximum cutting height is 3.5 inch. 5) The run time is 45 min. / fully charged batteries. 4.2 Discussions:- Below 40 degrees of inclination angle of the push handle, the mower handle becomes very uncomfortable to handle and pushing the mower becomes quite difficult. At an angle of 45 degrees, the handle is found most convenient in terms of freedom in moving the mower. In future we can add the Remote sensors to the Lawn Mower to operate it by the remote control.

## VIII. CONCLUSION

In the presented paper provides the fabricated information about the “Fabrication of automated Solar grass Cutting Machine” which was designed such that the solar plate generates solar energy and utilizing this energy for running the grass cutter motor. Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using highly advanced IC’s with the help of growing technology, the project has been successfully implemented. Thus the project has been successfully designed and tested. The idea can be extended by adding more features like displaying the solar voltage generated on LCD display unit, also alerting when the battery voltage level goes low below threshold limit. We can add an interfacing of automatic power bank to charge the battery instantly. It can also be extended using driver circuits for controlling intensities, speed levels of the motor. Extensions using Wireless remote controls like RF, zigbee, Wi-Fi networks through which the grass cutter model can be operated from a distance by the user

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