

Design and Fabrication of Eco Friendly Pedal Operated Lawn Mower for Agricultural Applications

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Abstract: Mowing the lawn with a standard motor powered lawn mower is an inconvenience, and no one takes pleasure in it. Motor powered push lawn mowers and riding lawn mowers create noise pollution due to the loud engine, and local air pollution due to the combustion in the engine. Also, a motor powered engine requires periodic maintenance such as changing the oil. Even though electric lawn mowers are environmentally friendly, they too can be an inconvenience, along with motor powered lawn mowers; electric lawn mowers are also hazardous because of the high machinery & electric shocks and cannot be easily used by all. In this work the pedal operated grass cutter is successfully designed and fabricated. This is a type of a grass cutter that is operated by the gears and the pedal of the cycle. This prototype is user friendly, cost efficient, safe to use, and environmentally friendly. It can save the labor costs in major applications in gardening works.

Keywords – pedal operated grass cutter, lawn mower, Cost Effective, Bevel gear mechanism

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I. INTRODUCTION

Now a day's environmental pollution is a main issue for whole world. Pollution is manmade and can be seen in our homes and environments. In case of gas powered or engine powered lawn mowers due to the emission of gases it is responsible for pollution. Also the cost of fuel is increasing day by day and hence it is not efficient. So the Pedal operated lawn cutters are introduced. Pedal operated lawn mowers can be described as the application of pedal of a bicycle run by man who in turn rotates a blade which does the mowing of a lawn. In large size of lawn in the park, schools, colleges, are maintained manually. The gardener used hand scissors used to cut and maintain lawn uniformly. It is not easy and also very difficult to maintain uniform size. Also a motor powered engine requires periodic maintenance such as changing the engine oil. Even though electric grass cutters are environmentally friendly, they too can be an inconvenience. Along with motor powered grass cutter, electric grass cutters are also hazardous and cannot be easily used by all.

II. MOTIVATION OF THE WORK

Basil Okafor (2013) designed a self-powered mower with the electrical source is called a cordless electric lawn mower machine. This machine was operated by a battery-powered worked dc electric motor. This was comprised a system of speed multiplication in terms of pulleys which drive the cutting blades mainly and the charging unit consist of a 12V alternator system and a lifting mechanism meant to change the height of cutter easily. This is attained by means of installed a v-belt pulleys with a minimal slip effect and also collapsible blades to decrease the shared problem of wear. The use of collapsible blades and incorporation of an alternator for recharging the battery make their design unique such that no engine power was involved. They concluded that the performance test were gave a cutting efficiency of 89.55% with 0.24kN of human effort also the machine was considered highly efficient and is readily adaptable to different cutting conditions. Below 40 degrees angle of the mower handle becomes very uncomfortable to handle and pushing the mower becomes quite difficult. Also found that at an angle of 45 degrees, the mower handle was most convenient in terms of degrees of freedom in moving the mower.

N.Nagarajan et al. (2017) proposed and fabricated a grass cutter with helix shaped blade. This system has been found to be most cost effective, compact, user friendly and less complex, which can readily and effectively be used in order to perform repetitive tasks. The spiral blade lawn mower was fabricated and tested successfully.

This vehicle does not have any engine and is required powered by the user. The components that were used are rotating wheel, gear arrangement, roller, rotating bearing, and base frame of vehicle. In that below the gear arrangement cutting blade was rotated. When the gear arrangements were rotated then the reel mover tends to cut the plants and crops. The reel consists of several helix shaped blades mounted to a rotating shaft. After several tests were conducted from that concluded the higher amount of grass cutting efficiency was obtained when the lawn is dry before mowing in the field. The vehicle is simply powered by manual method of pushing action as an input. Therefore, it can be used by both rural as well as urban residents also it was affordable since the cost of production and maintenance is low.

RubentheranSivagurunathan et al. (2017) published a principal and working of a hand-held type operated machine for the application of grass cutting has been designed and fabricated by using low cost and easily available materials. Important parameters such as durability, strength, and light weight were taken for design considerations given the better performance and good characteristics. Basically the lawn mower was powered by a 12V/1.35A rechargeable battery in this system which drives the DC motor up to a rotational speed of 19,300 RPM approximately. The generated torque will be transferred to the cutting machine mechanism for efficient way of grass cutting. The entire configuration in this fabricated set up was mounted on a light weight wooden base which attached together with a bicycle frame. This portable lawn mower generally used to maintain and trim grass in gardens, home, schools or yards etc.



Figure 1. Battery operated simple lawn mower(RubentheranSivagurunathan et al. 2017)

D.Satwik et al. (2015) presented a lawn mower with a spur gear displacement mechanism in this machine rotor blade height could be adjusted by using the lever attached to the machine. The fabrication work of the proposed machine has performed and the design of the machine has been done by using design software CATIAV5. ANSYS is used to perform static structural analysis between the spur gears which is available in this machine and contact stresses were predicted. The height of the grass cut of the lawn and required grass cut can be performed and the adjustment process would be completed within below 20 seconds. Arduino board was used to control the speed of the DC motor and the sensor was also placed in front of the machine. The required program was to be written and dumped into Arduino board. Below 30cm from the obstacle was identified by using the ultrasonic sensor which was provides in the board. The buzzer received a signal from the circuit board and produces alarm that prevents the collision.

III. OBJECTIVES

This work is an autonomous grass cutter that will allow user to the ability to cut their grass with minimal effort. Hence this work of design to make a grass cutter without any power source to reduce the power consumption. Design a pedal operated domestic lawnmower that utilizes man power as a power source is mean to address a number of issues that standard internal combustion engine mower do not. A pedal operated lawnmower will be easier to use. The major objectives of this work are indicated in the following Figure no. 2.

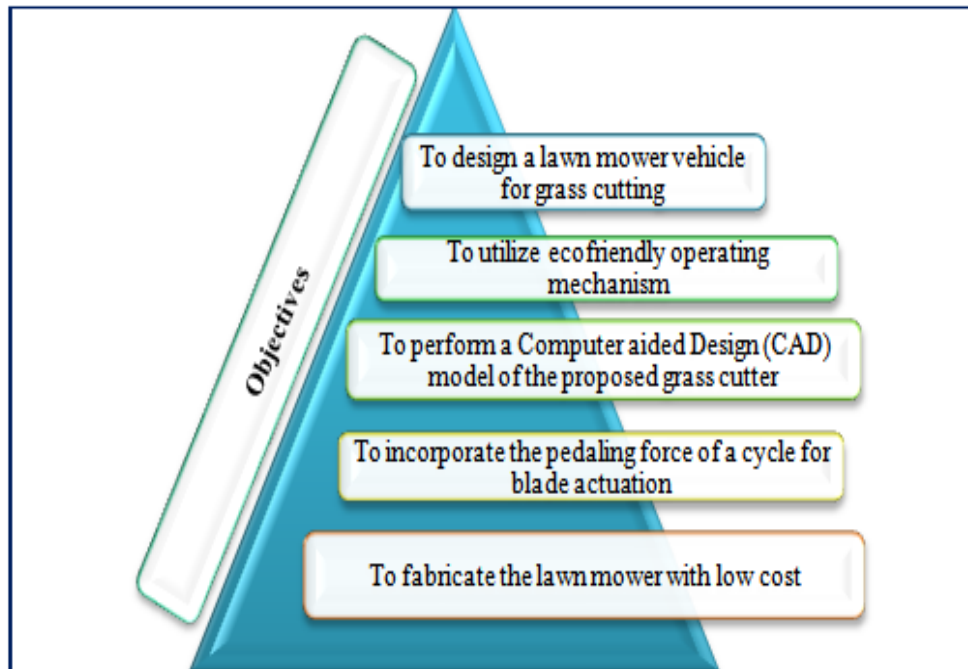


Figure no. 2. Objectives of the proposed design & fabrication work

IV. DESIGN OF PEDAL OPERATED LAWN MOWER

The pedal operated lawn mower is made up of a chassis, a bevel gear mechanism, a bicycle chain mechanism, four collapsible blades for cutting, and a height adjustable seat. The bevel gear mechanism forms the heart of the machine and provides the driving force for the collapsible blades. This is achieved by the combined effect of mechanical action of the cutting blades and the forward thrust of the mower. The system is powered by a manual pedaling operation. Lawnmowers employing a blade that rotates about a vertical axis are known as rotary mowers, while those employing a blade assembly that rotates about a horizontal axis are known as cylinder or reel mowers. Pedal operated lawn mower are based on the use of small but powerful bevel gear mechanism that provides enough torque to spin a very sharp horizontal blade that cuts the grass upon contact. The blade is located in the rear that prevents grass from flying all over the place when struck. It uses the man power to generate the energy needed to power the mower. The main components of the Pedal Powered Grass Cutter are as follows,

- 1) The chassis
- 2) A bevel gear mechanism
- 3) A bicycle mechanism
- 4) Four collapsible blades / Cutter
- 5) An adjustable seat for comfort .

The CAD model of the designed frame of the cutting machine is shown in the following figure.no 3.

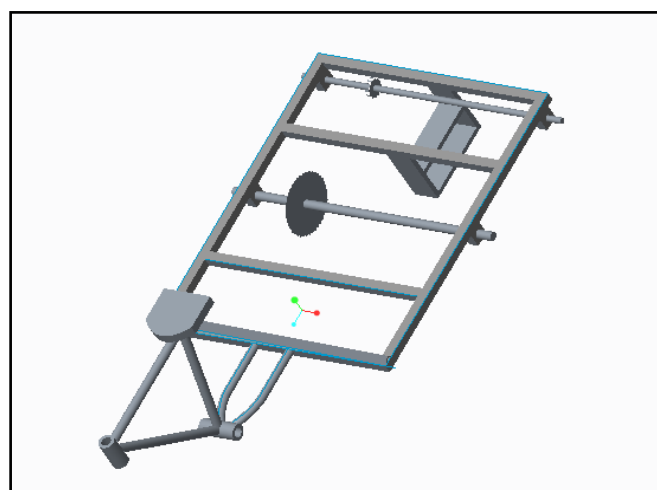


Figure no. 3. Initial CAD model of the proposed frame of the machine



Figure no.4. Fabricated model of the pedal operated Gross cutter

It is a three wheeled pedal operated lawn mower, two rear wheels and one front wheel as shown in figure no. 4. The Pulling forces applied on the handle which rotates the rear wheel. The shaft between rear wheels which connected to the compound gear train. The gear train increases the gear ratio. Gear train meshes with straight bevel gear which converts the forward motion to the vertical motion. The blade is connected to the bevel gear. This gear train increases the speed of the cutting blade. Shafts of the gears are connected to the bearings. The bearings are used for the shaft stability and frictionless rotation. The lubricant is used for bearings is ester oil. Straight bevel gear is used in this lawn mower because of its simple design and low speed. The cutting blade is a low lift blade used for the low speed. The major mechanical components were shown in the figure no. 5.

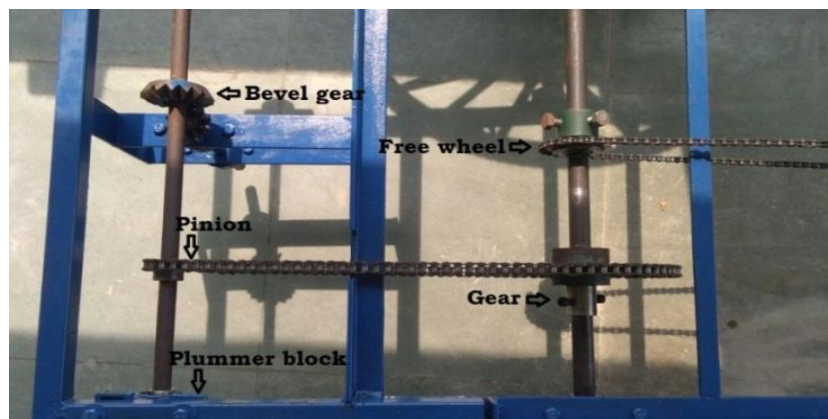


Figure no. 5. Mechanical Components of the pedal operated Gross cutter

Chassis & Frame Specification

- The chassis is made of (30x30) mm square tube.
- The total length of the frame is 1000mm.
- The width of the frame is 800 mm.
- The thickness of the tube is 4mm.

Components and Their Specifications

- Shaft = 25mm.
- Bevel gears = the machine uses the bevel gears in the 1: 1.6 ratio.
- Plummer block = 25mm.
- **Sprockets:**
- Number of teeth in the sprocket at the pedal of the machine is 44
- Number of teeth in the sprocket at the centre of the machine is 22
- Number of teeth in the sprocket at the side of main shaft is 54
- Number of teeth in the sprocket at the rear of the machine is 12
- The ratio between the sprockets at the rear and center is 1: 9

Blade:

- Length of the blade is 600mm
- Thickness of the blade is 2.5mm
- Angle of the blade is 18-20°
- Material of the blade is Stainless steel.

Design Calculation

- The area of the blade = (length x width)
- Mass of the blade = (density x volume)
- Density of stainless steel = 7922 kg/m³
- Mass of the blade = $7922 \times 37500 \times 10^{-9} = 0.2971$ kg.
- The weight of the blade, $W = Mg$
 $= 0.2971 \times 9.81$
 $= 2.915$ N
- $r = 600/2 = 300$ mm
- Torque (T) = $W \times r$
 $= 2.915 \times 300$
 $= 874.5$ Nm
- Speed ratio from pedal to blade shaft = $9 \times 1.6 = 14.4$
- Pedaling operation takes place at an average of 12rpm. i.e., 0.2rps
- Hence, blade rotates in $N = 12 \times 14.4 = 172.8$ rpm
- Angular velocity $\omega = 2\pi N/60$
 $= 2 \times 3.142 \times 172.8/60$
 $= 18.098$ radian/s

Advantages

The pedal operated grass cutter has some useful advantages. They are as follows:

- 1) The basic advantage of the grass cutter is that it reduces the pollution.
- 2) By operating this machine the peddler can become health cautious and maintain respective physical fitness.
- 3) The blade height can be varied accordingly to the required clearance.
- 4) The system does not require any power source to drive the machine.
- 5) The initial and the maintenance costs are comparatively less than the normal grass cutters.

V. CONCLUSIONS

This project helped us to improve our practical knowledge and also to express a new idea on the fabrication of new type of grass cutting machine. However by completing this project, we feel that our aim and objectives of the project is fulfilled. Manually operated rotary lawn mower is fabricated with locally available materials. The manually operated rotary lawn mower works without power and fuel.

- The gear train mechanism and bevel gear system used to rotate the cutting blade.
- By this lawn mower can cut variety of grass lawns with maximum blade cutting efficiency of 90%.
- Energy expenditure on operating this model requires fewer calories.
- It can be operated easily and economically cheaper.
- After the fabrication of the machine it was tested for cutting stubborn types of grasses and it succeeded effectively. The cutting blade is designed keeping in view of the force required to cut the lawn.
- It depends also on the height, density and the area covered by the object.
- Therefore, in designing the blade for the pedal operated grass cutter, the force required for effective mowing is kept greater than 10 Newton.

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