Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 05, May-2019

Design and Fabrication of Hybrid Operating Grass Cutter

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***Abstract* - 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.**

Key Words: ***D.C motor, solar powered, lawnmower, mowing, solar energy***

1. INTRODUCTION

Hybrid powered grass cutter can be described as the application of solar energy to power an electric motor which in turn rotates a blade which does the mowing and trimming of lawn each to suit a particular need or convenience. It uses the photovoltaic panel to generate the energy needed to power the mower. The hybrid powered grass cutter will help to reduce air pollution as well as noise pollution produced by other types of grass cutter. Rotary mowers are based on the use of small but powerful engine that provides enough torque to spin a very sharp horizontal blade that cuts the grass upon contact.

2. OBJECTIVE

The objective of the project is to design the hybrid powered grass cutter which operates upon solar energy and avoids the drawback of old grass cutters. The purpose is to avoid fuel consumption and reduce the human effort, operating cost and maintenance cost. Also solar based grass cutters are environmental friendly it is used for various applications. The whole machine operates on the solar energy which is stored in battery.
The objectives of the project are:

- To replace the existing grass cutter with the hybrid operated grass cutter.
- To integrate mower and trimmer that can be used simultaneously.
- To work on both solar as well as electric power.
- To reduce the cost of the grass cutter.
- It can be operated by unskilled labours.
- To make it environment friendly.

3. METHODOLOGY

Basically it consist of a rectangular framing section handle, DC gear motor, sheet metal, tyres, solar panel battery etc. In operation the solar energy absorbed by the solar panel is been stored in the battery and the energy stored into the battery will be used for further operation. The hybrid grass cutter uses an eliminator to use AC current to run the cutter. The operator just needs to push the machine in which ever direction he needs then he just needs to switch on the motor as soon as the motor is switch on the cutting action gets activated and these blades are been attached to the shaft of the motor as the blade gets mesh up with the grass the grass gets cut.

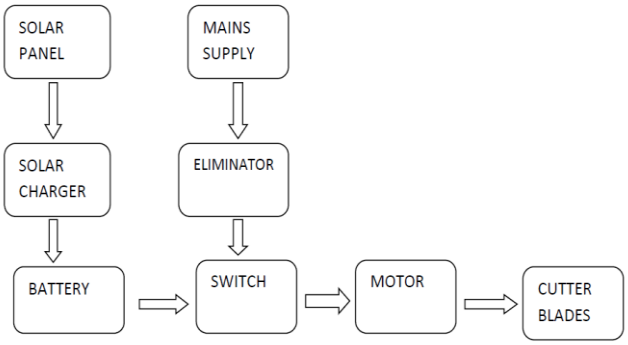

Fig-1: Flowchart of methodology

4. LITERATURE SURVEY

Mary Bellis:
In the United States, gasoline-powered grass cutters were first manufactured in 1914 by Ideal Power Mower Co. of Lansing, Michigan, based on a patent by Ransom E. Olds. Ideal Power Mower also introduced the world's first self-propelled, riding lawn tractor in 1922, known as the "Triplex". The roller-drive lawn mower has changed very little since around 1930. Gang mowers, those with multiple

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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sets of blades to cut a wider swath, were built in the United States in 1919 by the Worthington Mower Company.

Praful.P.Ulhe:
In this paper they have prepared manually operated grass cutter with spiral roller blades due to spiral blades increases the efficiency of cutting. For adjusting the height reel cutter is component placed on grass cutter. This grass cutter used to cut the grass uniformly and also it can cut the different types grasses. The battery can be charged during working conditions and it also having AC charging. For collection of cutting grass cutting box is placed over grass cutter so the cut grass put outside the lawn. It is having light in weight and compact in design.

T.Karthick.et:
This paper author fabricated grass cutting machine with rotary blades by using solar energy. The solar energy is trapped in the photovoltaic cell to generate electricity. The cells may be grouped in the form of panels or arrays. Solar panel is placed such that to absorb high intensity from sun and it will incline at 45 degree . The main function of solar charger is increased current during batteries are charging and also disconnect when they are fully charged. Circuit's breakers are used to start or stop the motor. By considering ground clearance they can adjust the height of grass.

Prof.C.J.Shinde:
In this paper they have prepared manually handle device which is capable to cut the grass. This device consists of linear blades and it does not affected by climatic conditions. The main objective of this paper is to move the grass cutter is different directions to prepare various designs as per requirements. By using link mechanism the height of the cut can be adjusted. The unskilled labour can easily operate this device.

Thomas Green Son:
He introduced a mower called the Silens Messor (meaning silent cutter), which used a chain drive to transmit power from the rear roller to the cutting cylinder. These machines were lighter and quieter than the gear-driven machines that preceded them, although they were slightly more expensive.The rise in popularity of lawn sports helped prompt the spread of the invention. Lawn mowers became a more efficient alternative to the scythe and domesticated grazing animals

5. PROBLEM DEFINATION

The past technology of grass cutting is manually operated by the use of hand devices like scissors and knives, these results into more human effort and more time required accomplishing the work. Also in the past methods lack of uniformity for the remaining grass. Also due to the use of engine powered machines increases the air and noise pollution also this grass cutter require maintenance. Gas or fuel grass cutters do create pollution and noise due to combustion in the engine and their engine requires regular maintenance such as cleaning or replacement of air filter, engine oil and spark plug. The cost of these grasses-cutting machine are also high

6. WORKING PRINCIPLE:

It has panel mounted on top of model in a particular arrangement such that angle of inclination is 45 degree hence it can be receive solar radiation easily. Solar panel converts solar energy into electrical energy. This electrical energy is stored in the battery. The motor is connected to the battery through connecting wires. The cutting blades tap the power from DC motor and which in turn actuates the blades and hence rotating blades cut the grass. It also works on direct electric current by using eliminator it can extract electric current directly from the switch board and the motor wires are directly connected to the eliminator which then helps the blades to rotate and hence cut the grass. The placement of the blades is such that the mower blade is placed ahead of the trimmer blade at a ground clearance of 3 inches and the trimmer blade is placed behind mower blade at a ground clearance of 1.5 inches . Thus , the hybrid grass cutter does the action of mowing and trimming large and smaller grasses together in a single operation.

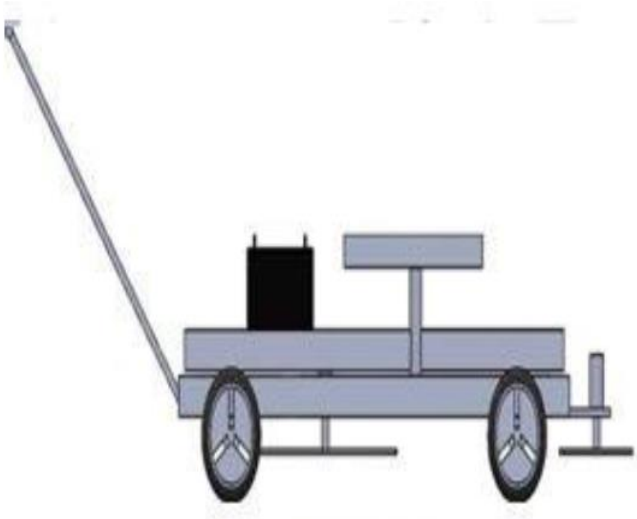

Fig -2: Side view showing the placement of blades

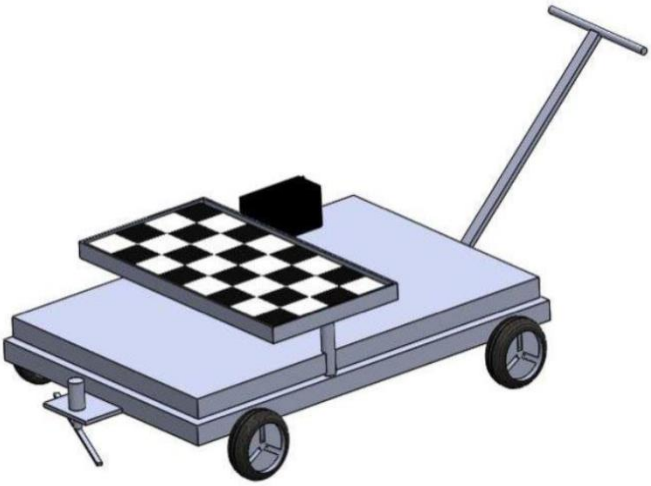

Fig-3: Isometric view

International Journal of Engineering Research & Technology (IJERT)
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7. COMPONENTS USED

Item number	Part name	Specifications	quantity	Material
01.	Square rods	2.7*2.7*0.13 cm	10 ft	Mild Steel
02.	Blades	32 cm	2	Steel
03.	Round rods	Diameter 1.5cm	3.6 ft	Polished Stainless steel
04.	Bearings	OD 4cm ID 1.5cm	4	Chrome steel
05.	Nut	M 10	6	Mild steel
06	Bolt	M 10	6	Mild steel
07.	Electric cable		10 meters	Copper
08.	Wheel	Diameter 22 cm	4	Rubbers
09.	Switch	-	2	Plastic
10.	Solar charger	12V	1	Plastic
11.	Solar Panel	12V,5W	1	Silicon
12.	Battery	12v, 7.5Ah	1	Lithium ion
13.	Motor	12v,800rpm	2	Magnetic steel

8. CALCULATIONS

For the design of blade, the force require to cut the gears and force acting on the table was considered.
Generally a force of less than 10n is required to cut he grass therefore inn designing the blade ,the force must be greater than 10N .

Blade area = length*width ……...….(I)
= 320 * 30
= 9600 mm2
t= thickness of blades = 0.9mm
Therefore,
Volume of blades = area * thickness ……(II)
= 9600 * 0.9
= 8640 mm2
The density of blade material made up of stainless steel C40 material (Design data handbook by H.G.Patil) is 7857 kg/m3
Mass of the blade (m) = density * volume ……(III)
= 7857 * 8640*10^-9
= 0.066 kg
Weight of the blade, (w) = mg……(IV)
= 0.066 * 9.8
= 0.64 N
Radius of the blade, (r) = 320/2
= 160 mm
Torque on cutting blade, (T) = w*r ……(V)
= 0.64*160*10−3
= 102.4 N-mm
= 0.1024 N-m
The speed of the rotating blade is N=800rpm
Angular velocity, (ω) = (2πN)/60……(VI)
= (2*3.14*800)/60
= 83.7 rad/s
Power required, (P)=T* ω
=0.102*83.7
=8.46W.
=0.11hp.

The force produced by the blade is the centrifugal force
Fc=m*ω2*r.....(VII)
= 0.066* (83.7)2*160*0.001
= 73.98 N
Frame design :
A mild steel square bars are used in the construction of the frame because of it's availability, strength, workability and cheap. The frame supports the battery, electric motor, eliminator and solar panel and handle frame. They transmit the load of 8kg and its length is 20" = 508mm
where P is the load on each wheel = (8*10)/4 = 20 N
Therefore, Bending moment, (M) = PL/4 …….....(VIII)
= (20*508)/4
= 2.54 N-m
From the data hand book,
Yield stress = 200 N/mm2
Allowable shear stress = (1/√3)*yield stress ……(IX)
= 0.577 * 200
= 115.4 N/mm2
Efficiency calculations:
Efficiency, E=Pout/Pin.....(X)
= (20.94/22.8)*100
= 91.85%

9. RESULT

The hybrid powered grass cutter is and fabricated. Test was carried out with several numbers of trials and summarized as shown in table

Sample plot	Height of the grass before mowing (mm)	Height of the grass after mowing (mm)	Expected height of the grass after mowing (mm)
Trail 1	111	92	85
Trail 2	97	89	85
Trail 3	92	90	85
Trail 4	81	81	85

Table 1: Test for mower blades

Sample plot	Height of the grass before mowing (mm)	Height of the grass after mowing (mm)	Expected height of the grass after mowing (mm)
Trail 1	92	34	30
Trail 2	89	32	30
Trail 3	90	33	30
Trail 4	81	32	30

Table 2: Test for trimmer blades

1. The area of cut (battery duration) depends on lawn conditions, grass density, moisture content, grass length and height of cut.

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2. Switching the product on and off frequently during cutting will also reduce the battery duration.
3. To improve the efficiency of cut it is recommended to cut more frequently and walk at normal pace.
4. The minimum cutting length for mower blade is 3 inches and that for trimmer blade is 1 inch.
5. The run time of the battery is around 2-4 hours for a fully charged battery depending upon the conditions and density of grass to be cut.

10. DISCUSSION

Below 40 degrees of inclination angle of the path handle, the handle becomes very uncomfortable to handling and pushing the grass cutter becomes quite difficult. At an angle of 45 degrees, the handle is found most convenient in terms of freedom in moving the grass cutter. From Table 5.1, the average height of the grasses after mowing was greater than the expected height after the machine has been used for cutting for the four trials of grasses. The efficiency of the machine was found to be 92% and the effective field capacity was 1.11×10^{-4} ha/hr. The results of the trimmer blade as shown in table 2.

It can be deduced that the reduction in the height of cut grass occurred in the case of stubborn grass. For trial 1, the initial height being 111mm and the final height being 34mm giving difference of 77mm. For trial 2, the initial height being 97mm and the final height being 32mm, a difference of 65mm. For trial 3, the initial height was 92mm and the final height was 32mm, a difference of 60mm. For trial 4, the initial height was 81 mm and the final height was 32mm giving a difference of 49mm. In all, the machine has performed creditably well.

11. CONCLUSION

In the world today, all machines are designed with the aim of reducing or eliminating green house gas emissions which is the major causes of climate change. This hybrid operational grass cutter will meet the challenge of environmental production and low cost of operation since there is no cost for fuelling. A hybrid operational grass cutter has been developed for the use of residences and establishments that have lawns where tractor driven mowers could not be used. The machine's capacity is adequate for its purpose. The device combines the mower and trimmer in a single set up to reduce the operational costs and efforts of using the mower and trimmer separately. Also it can be operated on both DC and AC current. The machine has proved to be a possible replacement for the gasoline powered lawn mowers.

12. FUTURE SCOPE

Man is always trying to develop more and more modified techniques with increasing aesthetic look and economic considerations. Hence there is more and more scope towards whatever he might have created, of course after having the experience of presently manufacturing the things. We completed our project successfully with the available resources. 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 efficiency can be improved by increasing the battery capacity
- By using light weight materials for the frame and handle the weight of the assembly can be reduced
- By using the cutter blade with high strength and increasing power used, the can be used for many applications in agricultural sector like shrub cutting, maize cutting, cane cutting.
- Currently the project is manually operated one, so we can further automate the grass cutter to be a remote controlled one so that it can reduce the efforts of manual pushing.
- Efficiency can be improved by increasing the battery capacity and improving the blade design.

Advantages

- The device is completely eco-friendly so the grass cutter has no harmful effects on the environment
- The device incorporates the mower and trimmer together in a single device.
- The device can perform both the trimming and mowing action simultaneously.
- Since it has a mower and trimmer both in a single setup the costs can be reduced and hence making it cost effective.
- It can be operated both on solar energy and electric energy.
- It is portable and can be operated even by an unskilled person.

Applications

- To cut the lawn in cricket ground, football ground and other playgrounds.
- To cut the unwanted grasses and weeds in gardens.
- In agricultural purposes to cut the stems of rice, maize, jowar and other similar crops.

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