Semi-Automatic Grass Cutter Machine

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Grass cutter machines have become very prevalent currently. Most of the times, grass cutter machines are used for soft grass cutting. In a time where technology is integrating with environmental sentience, consumers are considering for ways to provide to the relief of their own carbon footprints. Pollution is man-made and can be seen in our own daily lives, more precisely in our own homes. Herein, we recommend a model of the automatic grass cutting machine powered through battery. Automatic grass cutting machine is a machine which is going to accomplish the grass cutting operation on its own. This model reduces both environment and noise pollution. As world is moving towards automation, conventional systems are transformed into automated systems. So, having an automated grass cutter is need of the hour. In this project a conventional push grass cutter is modified into Semi-Automatic, RC controlled, battery powered, video surveillance grass cutter. Microcontroller is used to interface ultra-sonic sensors and Remote control with cutter motor and vehicle motors. If an obstacle is detected that is any living or non-living thing micro controller stops all motors and cutter moves backward so that operator can guide it away from obstacle.

Keywords:
Grass cutter machines, Video Surveillance, RC control, conventional grass cutter

1. Introduction

In 18th century the concept of grass cutter was just a mechanical machine which was manually operated. With the invention of engines, petrol engines were used to power cutters [1]. Now a days there are many types of grass cutters with various feature’s like solar powered, Petrol engine RC operated but they do not provide the ease to its user [2]. User has to go outside regardless of the weather condition or has to remain insight in order to move it properly. Semi-Automatic provide this ease to its user, he/she can remain in his room and through video surveillance and help of long range Rc [3]. It consists of DC motors, micro controller [4], Relays, 12v DC battery, obstacle sensor, camera. The cutter motor has 3000rpm and the vehicle motors have 180rpm in order to attain 3-5miles/hr. speed[5].

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Cutter is provided a high rotational speed to provide enough momentum to grass so that it stores in its back chamber. Semi-Automatic grass cutter is a feasible product for home lawns and sports grounds. It has a user-friendly interface to minimize the work load [6]. It is a very handy product which can be operated from a long range approximately 600m. It comes with variable cutting height options, depending upon the size of grass or terrain in which cutter is operated its cutting height can be changed to ensure smooth cutting and save the cutter from any damage. After cutting waste grass can be removed from the chamber by simple unhooking the chamber from its position manually. Storage facility ensures that lawn does not require any cleaning.

In current time earth is facing severe environmental issues causing severe weather conditions due to excessive burning of fossil fuels and are depleting with passage of time, so it was necessary to develop a product which is environment friendly and ensures the safety its user by saving him from extreme weather conditions [7].

![Project Picture](image_url)

**Figure 1. Project Picture**

2. Methodology

Semi-automatic grass cutter is a RC control device used to cut the grass at variable heights using rechargeable batteries [8]. Two 12V DC batteries are used along with two vehicle motors for forward movement of the cutter as well as for steering and a high-speed high torque DC motor for cutter. Figure 2 shows the methodology block diagram of the cutter.
Following are the components that are being used in this product:

- RC controller 6-channel
- Relays
- Arduino mega
- Camera
- Ultrasonic sensors
- Batteries
- DC motors

The above-mentioned blocked diagram working is described as the signal from the RC remote goes into the microcontroller that interprets it and pass it further to the relays that drives the motors [9]. If an obstacle is detected the signal goes into the microcontroller and pass it to the relays to stop the motors. The main aspect of Semi-Automatic, RC controlled, battery powered, video surveillance grass cutter is to ensure the safety [10]. The batteries are used to power the Aurdino as well as the motors the camera gives us a video feedback to control the cutter [11]. Programming for this project is done on Aurdino.

3. Calculations and Results

The main content of calculations on which our project basically relies are given below:

- Total Resistance
  - Air Resistance
  - Rolling Resistance
  - Gradient Resistance
- Tractive Effort
- Torque Required
- Power Required
- Motor Selection

3.1 AIR RESISTANCE:

Formula for calculating Air resistance is given below:
05(\(\rho C_d A_f v^2\))

3.2 DENSITY:

As semi-automatic grass cutter is used to move in open air in grassy areas so the only resistance that comes in its way is the air so for this, we use the density of air to calculate the Air resistance.

\[ \rho = \text{Air density taken as } 1.202\text{kg/m}^3 \]

3.3 COEFFICIENT OF AIR RESISTANCE:

It is the constant value and it cannot be change for air. The value for coefficient resistance is given below [12]:

\[ C_d = 0.458 \]

3.4 FRONTAL AREA:

As semi-automatic grass cutter is basically related to car dynamic to move forward or backward so to tackle air resistance frontal area will be calculate by the following formula. [13]

\[ \text{F.A} = B \times H \times 0.8 \]

Base of cutter body=289mm
Height of cutter body=214.51mm

After measuring values, the frontal area that we calculate is given below:

\[ \text{F. A}. = 289 \times 214.51 \times 0.8 \]

\[ \text{F. A} = 0.049m^2 \]

3.5 RELATIVE VELOCITY:

This is the average wind speed in Taxila while having a cloudy condition, so basically it will be use as velocity of wind while calculating Relative velocity. Formula for relative velocity is given below:

\[ (v_{body} + v_{wind})^2 \]

As our aim is that cutter body moves with velocity of 3-5mile/hr. or 1.3412-2.2352m/s.

For a safe limit we will take the higher value so we take velocity which is given below

\[ v_{body} = 2.2352m/s \]
As at this velocity body will face most Air Resistance from head wind. On a windy day in Taxila

\[ V = 8 \text{km/hr.} = 2.22 \text{m/s} \]

After measuring the velocity of body and the velocity of wind we find the relative velocity that is given below:

\[ V = (2.2352 + 2.22)^2 \]

\[ V = 19.84 \text{m/s} \]

So, at the end we combine all these resistances to find the air resistance which is given below:

\[ A. R = 0.05(\rho C_d A_f v^2) \]

\[ A. R = 0.5(1.202 * 0.458 * 19.84 * 0.049) \]

\[ A. R = 0.26759 \text{ N} \]

3.6 **ROLLING RESISTANCE:**

The formula to find a rolling resistance is given below [14]

\[ R. R = F_r \times mg \]

Here,

"\( F_r \)" is the rolling friction which is a constant value.

"\( m \)" is the mass of the body.

"\( g \)" is the gravitational acceleration.

\( F_r \) between Grass and flattened Grip Tyre of bicycle

\[ F_r = 0.007 \]

We choose tyre of bicycle because the tyre that we use in our project is same as used in small bicycles.

Mass of the body is given below:

\[ \text{Mass} = 15 \text{kg} \]

Gravitational Acceleration is given below which is a constant value.

\[ g = 9.80665 \text{N/ m}^2 \]

Rolling Resistance that we calculate from here is given below

\[ R. R = F_r \times mg \]
3.7 \textit{GRADIENT RESISTANCE}:

Max. Gradient which is expected from a car to climb is of slope 1 of 5 i.e. 20%.

Formula for gradient resistance is given below:

\begin{equation}
G.\text{R} = \frac{mg}{5} \times 15 \times 9.80665
\end{equation}

\begin{align*}
G.\text{R} & = \frac{15 \times 9.80665}{5} \\
& = 29.41995\text{N}
\end{align*}

3.8 \textit{TOTAL RESISTANCE}:

- Total Resistance= Air Resistance + Rolling Resistance + Gradient Resistance
- Total Resistance=0.26759+29.41995+1.029
- Total Resistance=30.695\text{N}

3.9 \textit{TRACTIVE EFFORT}:

It is the amount of force a wheel can apply to a surface before it slips.

\[ F = \mu_t mg \]

Here,

\[ \mu_t = \text{coefficient of traction} \]

As semi-automatic grass cutter will move on a grassy surface so co-efficient of traction for grass is:

\[ \mu_t = 0.5 \]

Tractive effort for one driving wheel is given below:

\[ F = (0.5 \times 15 \times 9.80665)/4 \]

Here, divide by four is just because body consists of four tyres.

- For one driving wheel
\[ F = 18.387 \text{N} \]

- For 2 driving wheels
  \[ F = 18.387 \times 2 \]
  \[ F = 36.774 \text{N} \]

\[ \text{T.E} > \text{T.R} \text{ so } 36.774 \text{N will be sufficient for to drive the cutter.} \]

3.10 TORQUE:

Now, to move a 15 kg semi-automatic grass cutter we need a torque that will be able to move a body. Formula for calculating torque is given below.

Torque = F\*r

"F" is the tractive effort.

"r" is the radius of tyre.

Radius of tyre is given below

\[ r = 85 \text{mm or 0.085} \text{m} \]

Torque that we find is given below:

\[ T = 36.774 \times 0.0850 \]

\[ \text{Torque} = 3.1256 \text{Nm} \]

3.11 POWER REQUIRED RANGE:

By taking the minimum velocity that is:

\[ V = 1.3412 \text{m/s} \]

We calculate the power required which is given below:

\[ \text{Power} = F \times V \]

"F" is the tractive effort

"V" is the velocity

\[ \text{Power} = 36.774 \times 1.3412 \]

\[ \text{Power} = 49.29384 \text{watts} \]
By taking the maximum velocity that is:

\[ V = 2.2352 \text{m/s} \]

We calculate the power required which is given below:

\[ \text{Power} = F \times V \]

\[ \text{Power} = 36.774.2 \times 2.2352 \]

\[ \text{Power} = 82.1972 \text{watts} \]

So, the power required range is from

\[ 49.29384 \text{watts} - 82.1972 \text{watts} \]

### 3.12 SELECTION OF MOTORS:

Our Aim is to the semi-automatic grass cutter at the speed of

3-5 miles/hr. or 1.3412-2.2352 m/s

Motor available in the market has following attributes:

**MOTOR A:**

- \( N = 180 \text{ rpm} \)
- \( \text{Power} = 120 \text{ watt} \)
- \( \text{Voltage} = 12 \text{V} \)
- \( \text{Amp} = 7 \text{amp} \)

**MOTOR B:**

- \( N = 120 \text{Rrpm} \)
- \( \text{Power} = 60 \text{watt} \)
- \( \text{Voltage} = 12 \text{V} \)
- \( \text{Amp} = 2.5 \text{amp} \)

Radius of tyre is given below

\[ r = 0.085 \text{m} \]

Velocity achieve by this motor is given below:

\[ V = \left( r \times 2\pi N \right) / 60 \]

\[ V = 1.602216 \text{m/s} \]

Torque achieve by this motor is given below:

\[ \text{Torque} = \frac{p \times 60}{2\pi n} \]

\[ \text{Torque} = \frac{120 \times 60}{2\pi} = 6.366 \text{Nm} \]

**MOTOR B:**

\[ \text{Torque} = \frac{60 \times 60}{2\pi} = 4.77 \text{N} \]
Objective fulfilled.  

Objective failed (due to speed is less)

4. ANALYSIS

Stress Analysis shows that strain produced as a result are with in safety limits of material of the body.

C.G was found to know whether addition of mass had any effect on distribution of mass which would further affect the dynamics of cutter. Total weld mass, Surface Area and Volume and their respective moment of inertia were also found.[15]

5. Conclusions

Semi-Automatic grass cutter is a modern-day tool which eases life of its user by saving his time, saving him from extreme weather conditions and providing an interface which is easy to use. The project has opened a gateway for variants like semi-Automatic multiple Crop cutter, which will bring revolution in agriculture field. As prices of fuel are rising and world is moving towards renewable
energy a cutter which is semi-automatic and after further improvements whose energy sources (batteries) would be charged from solar energy will be need of the hour.

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