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Automatic Grass Profile Cutter

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Abstract:

This paper deals with designing and fabrication of an automatic grass profile cutter. It is simple to construct and easy to operate. It can be used in the modern agricultural field and also appealing visualization of lawns. For example, creating a college logo with the help of this profile grass cutter without any manual help. In the earlier days, mowing the lawn with a standard motor driven lawn mower is an inconvenience and no one enjoys it. Also, grass cutting cannot be easily done by elders, disabled people or even youngsters. This profile cutter is user friendly, safe, efficient to use, cost efficient and is also environmentally friendly. This profile cutter is automatic and runs on charged batteries to interfere with operation without any cords. This self-propelling lawn mower with autonomous capability allows ordinary people to use this equipment easily. As per the program, this grass cutter cuts a square profile in the lawn.

Keywords**:** Profile, Grass Cutting, DC Motor, Omni Wheel, PIC Microcontroller

1. Introduction

Due to the inconvenience of the traditional lawn mower we make an automatic lawn mower with profile cutting facilities. Conventional mowers are run with standard motor power so it requires high manual energy to be used in the application field. This automatic profile cutter is powered by battery energy. Therefore it does not require any manual intervention; it can be easily controlled by all types of age groups. This prototype is a profile cutter that is user-friendly, cost efficient, safe to use, efficient to use, and environmentally friendly. The prototype will also be automated and run on a charged battery with no cords to interfere with operation. This self-propelling lawn mower includes autonomous capability that is user-friendly, so most consumers will be able to this device. The primary objective of the work is to apply basic knowledge of engineering design in a practical application. Therefore the project focuses on each engineering step which begins with the design idea of a profile grass cutting. The primary phase of the project consists of design calculations and profile mowing design drawings. The second and final phase of the project is the construction of the designed project. The third step is to create a program for a specified profile, then use a controller to use the program and run the machine accordingly. The main components used in this prototype manufacture are profile cutting blades and DC motors for omni wheel movement. Profile cutter, omni wheel smoothly and to reduce the curvy motions of grass cutters. The Arduino software is for reading the program and converts it into an operation by attaching it to a cutter. Select the DC motor and profile cutter blades only after the DC motor selection calculation and profile cutter blade calculation were performed. This prototype is designed to cut grass evenly, as well as to cut square profiles on the lawn. We have circular bases that lift DC motors. We have 5 DC motors. The 4 DC motor is for 4 omni wheels and one blade for blade rotation. In this we need a system that can combine program software and hardware. The material chosen for the base and horizontal arm is according to the literature study.

This paper is framed with existing system in Section II, followed by Design calculation in Section III, components used in Section IV, working principle in Section V and Conclusion in Section VI.

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2. Existing System

In this literature study is highly concentrate on the process of random reflection navigation. The lawn mower is working on the above process which is used in vacuum cleaners. But this shows some quality issues like uneven mowing. For this problem they use localized algorithm to improvise the quality issues. This machine properly merges the data s from IMU to RFID antenna. This gives an idea about how to write algorithm [1-3]. Fuel and electrical energy is the most probably used in machine operations. In this literature study they make a lawn mowing machine which is running with help of fuels which is more costly and need more maintenance. But this profile cutter is cost effectively run with low maintenance. Obviously the author gave more importance on durability, strength, and light weight so we can get a clue that how to reduce total machine weight and increase the durability. They use 12V/ 13.5A battery with19300rpm speed. This is in the model of bicycle with 2 wheels [4-6]. The innovation part in this survey is that they using Hydrogen power for mowing the lawn. This model is a low maintenance advantage as well as light weight application. They used a lubrication oil for maintenance we are also used it for so. Metal hydride and external heat reaction is reduce the accidental tension, so it is a safety one. So we can get an idea about how to use gasoline for mowing [7]. Very big issue of the professional vehicles is the vibration behavior. This literature deals with the vibration behavior of lawn tractor. They use finite element analysis to reduce the vibrations. They used a multi body model concept. It was little bit like a meshing. So we can analyze the model in every minute area. Using this idea we are also done an ANSYS experiment for vibration analysis. Now we can reduce the vibration using the above concept. For while we can increase the life of the lawn mower and can get a better results [8].

3. BLDC Motor Calculation

Voltage, V = 12 Volt
Speed, N = 4000 RPM
Current, I = 2.5 A (maximum load condition)
Power, P = $V * I = 12 * 2.5$
= 30 $Watts$
Power = 0.08HP
Motor Efficiency = 80%

Electrical Power of the Motor

Electrical power of the motor is defined by the following formula:

$$Pin = I * V$$

Where,
Pin = Input power in watts (W)
I = Current in ampere (A)
V =Applied voltage measured in volts (V)

$$Pout = T * \omega$$

Where,
Pout = Output power in watt (W)
T = Torque in Newton meter (Nm)
ω = Angular speed in (rad/s).
If rotational speed is known, calculate the angular speed,

$$\omega = N * 2\pi/60$$

Where,
ω = Angular speed measured in (rad/s)
N = rotational speed in RPM
π =Constant pi (3.14)
60 = Constant (Seconds in a minute)

$$E = Pout/Pin$$

Therefore,

$$Pout = Pin * E$$

After substitution we get,

$$T * \omega = I * V * E$$

$$T * N * \frac{2\pi}{60} = I * V * E$$

Torque of the Motor

The formula for calculating torque will be

$$T = \frac{I * V * E * 60}{(N * 2\pi)}$$

$$T = \frac{2.5 * 12 * 0.8 * 60}{(4000 * 2\pi)}$$

$$T = 0.115\ Nm$$

$$Torque, T = 1.15 \text{ kg cm}$$

Calculation for DC Motor at Wheel

Speed, N = 78 RPM
Voltage, V = 12 Volt
Loading Current, I = 1 A

$$Power, P = V * I$$
$$= 12 * 1$$
$$= 12 \text{ Watt}$$

Power, P = 0.017 HP
Motor Efficiency E = 36%
Electrical power of the motor is defined by the following formula:

$$Pin = I * V$$

$$Pout = T * \omega$$

Calculate angular speed if rotational speed of the motor in rpm is known.

$$\omega = N * 2\pi/60$$

$$E = Pout/Pin$$

Therefore,

$$Pout = Pin * E$$

After substitution,

$$T * \omega = I * V * E$$

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$$T * N * \frac{2\pi}{60} = I * V * E$$

Torque of the Motor

The formula for calculating torque will be,

$$T = \frac{I * V * E * 60}{(N * 2\pi)}$$

= (1x12x0.36x60)/78x2π
= 0.528 Nm
Torque (T) = 5.38 kgcm

$$X = \sum A.X / \sum A$$

Center of Gravity

X= A1X1 + A2X2 / A1+A2
SECTION 1:
X1, Y1 = 0
A1 = πr^2 = 3.14 X 1902 / 4 = 149.22 mm2
SECTION 2:
X2 = 145mm , Y2 = 0
A2 = L x B = 100 X 10 = 1000 mm2

Centroid

X = A1X1 + A2X2 / A1+A2
= (149.22*0 + 1000*145)/149.22+1000
X = 126 mm
Y = 0 (since y1, y2 = 0)

4. Components Used

The profile cutter is fabricated with component based design parameters and is provided here with mechanical component fabrication drawings, construction detail drawings including electronic component pin descriptions. The components used are DC motor, omni wheel, PIC16f877a microcontroller.

DC Motor

DC motors are electrical machines that convert direct electrical energy into mechanical energy. DC motors rotates baed on the forces produced by the magnetic fields. All types of DC motors have some internal mechanism, whether electrical or electronic. It changes the direction of current flow in the motorperiodically. DC motors mostly produce rotary motion; A linear motor generates power and speed in a straight line. A 12 V DC motor is usedas shown in Fig. 1.

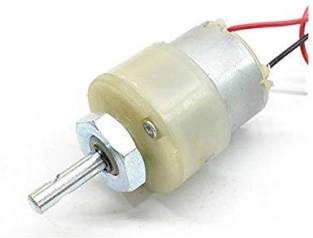

Figure 1: DC Motor

Figure 2: Omni Wheels

Omni wheels

Omni wheels or poly wheels that resemble function such as Mecanum wheels are used here. These wheels are provided small discs around the circumference which are perpendicular to the direction of turning. This enables the wheel to be driven at full force and it also slides easily later. These wheels are frequently employed in holonomic drive systems. The omni wheel is shown in Fig. 2. Here four omni wheels are used to ensure the speed of the cutter robot in all directions.

PIC Microcontroller

If a system is developed with a microprocessor, the developer needs to interface for external memory such as RAM, ROM or EEPROM and peripherals. Therefore the size of the PCB required to hold all necessary peripherals will be large. However, all the peripheral features in a micro controller are available on the same chip, so developing similar systems with a micro controller will reduce the PCB size and also increase the cost of design. The heart of the system here is the micro controller. It is used to control the entire unit.

The PIC microcontroller PIC16f877 is used to control the profile cutter robot. This controller is very suitable to use and the coding of this controller is easy. One of the main benefits is that it can be erased as many times as possible because it uses flash memory technology. It is a 40 pin microcontroller with 33 pins dedicated for input and output. An EEPROM memory is also depicted in it which makes it possible to store some information permanently such as transmitter code and receiver frequency and some other related data. This controller costs less and is also easier to handle. Therefore this micro controller has been chosen for the manufacture of profile cutters. The pin diagram of PIC16f877 is shown in Fig. 3

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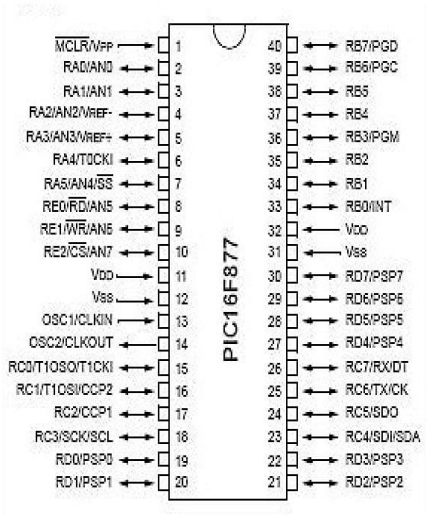

Figure 3: Pin diagram of PIC16f877 microcontroller

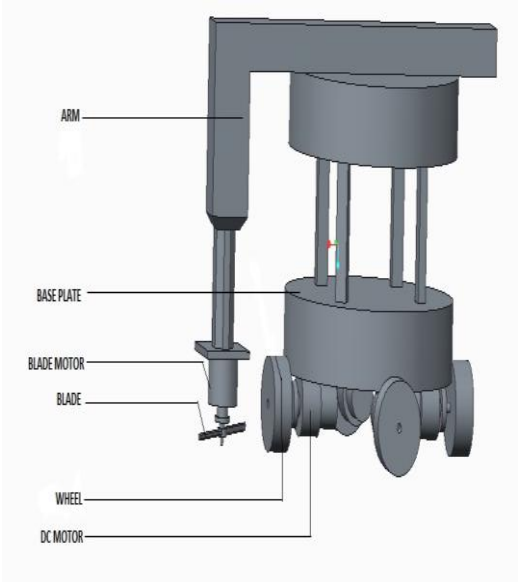

Figure 4: Assembled view of Grass Profile cutter

5. Working Principle

Here, the automatic profile lawn mower is designed and manufactured. It is an innovative concept that is mainly used to maintain the landscape in agriculture sector, colleges, schools, gardens. It is simple to manufacture and easy to operate. The components used are motor and mowing system. Four motors are used here for driving vehicles and one DC motor for mowing. A special wheel called omni wheel that can be used to move the cutter robot in both directions. This cutter enables the robot to move forward and backward. When the cutter robot is powered both by movement and operation, a separate DC is controlled by motors. The selection of a DC motor is briefly studied in the calculation field. The height of the cutting blade can be adjusted by bolt and nut. In some places the height and thickness of the grass may vary when we need to take care of the life of the blade as well as the quality of the cut, so we can easily adjust the height of the blade as needed.

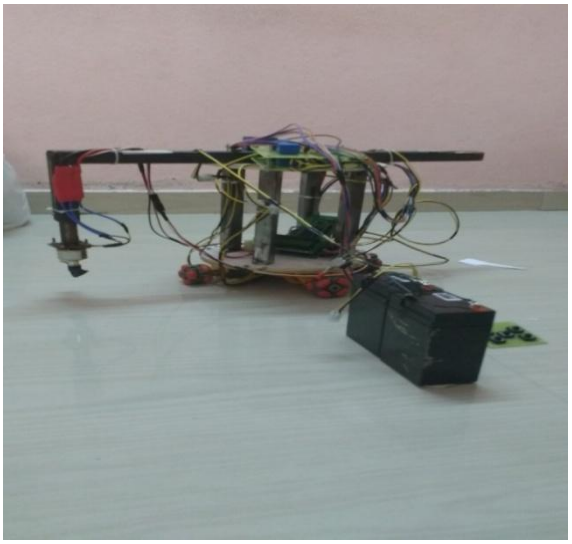

Figure 5: Grass Profile Cutter

The special feature of our work is to cut the profile structure without any manual intervention. For example, in a college garden lawn area they need to write a college logo means, they can use this cutter to write it without take much time and without need a skilled lawn mower. Here a Microcontroller is used to control the whole unit which includes motors and grass cutting arrangements. The micro controller is associated to the control unit. The power requirement of the control unit is served by the batteries. The assembled view of the profile cutter is shown in Fig. 4

The profile is made in the program. It was interconnected to the PIC microcontroller and profile cutter. In the profile cutter, there is receiver side that receives the command of the profile information. The PIC microcontroller was gave all the minute data to the grass cutter. Then it was started to move according to the profile design program. This robot is not only aesthetic purpose but also in modern agricultural practices. The fabricated grass Profile cutter is shown in Fig.5.

6. Conclusion

The grass profile cutter was designed to landscape the lawns automatically and it will evolve to serve its purpose without any profound flaws. The system, when implemented, it will help for easy maintenance of garden. It is an innovative concept mainly used in agricultural field. This profile cutter is made with pre planning to provide flexibility in operation. This is autonomous moving in all directions. The easiest operation is achieved by the control unit in "GRASS PROFILE CUTTER". The comparative advantage that can be accomplished is the use of the motor in the control unit. This serves to cut a profile of the square completely without blunder. It can be further programmed to cut different profiles in the lawn.

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References

[1] Nandish. B, Muthanna. K.P, Kaveriappa. M B, Biddappa. P. S, "Design and analysis of Grass mower", International Journal of Science, Engineering and Management (IJSEM), Vol 4, Issue 4, April 2019.

[2] Alessio Levartti, Matteo Bonaiuti, Cristian Secchi, b Cesare Fantuzzi, "An Inertial/RFID Based Localization Method for Autonomous Lawnmowers".

[3] K Yvuon J-L Lorenzoni , "Hydrogen-powered lawn mower: 14 years of operation"

[4] L Bertini, F Bucchi, BD Monelli, P Neri, "Development of a simplified model for the vibration analysis of lawn mowers"

[5] Basil Oka for, "Simple Design of Self-Powered Lawn Mower", International Journal of Engineering and Technology, Volume 3, 2013.

[6] Yong and Chow, S.H., "Design and Construction of an Improved Domestic Lawn Mower" Beijing Institute of Technology, China, 1991.

[7] Rubentheran Sivagurunathan, Linkesvaran Sivagurunathan, "Design and Fabrication of Low Cost Portable Lawn Mower"

[8] Sudhanshu G Chouhan, Sameer Ahmed Shaik, K Vamshi Krishna Reddy, Sai Rohith Bandaru, "Design of a Power Autonomous Solar Powered Lawn Mower" International Journal of Mechanical Engineering and Technology (IJMET), Volume 8, Issue 5, May 2017, pp. 113–123

[9] B. Bhandari (2010), "Design of machine elements", Tata McGraw Hill, New Delhi.

[10] PSG College of Technology (1966), Design data book, PSG College of technology, Coimbatore.

[11] Khurmi, R.S. and Gupta, J.K. "Machine Design" Eurasa Publishing House, Ltd. New Delhi, India, 2003