International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064

Smart Lawn Mower for Grass Trimming

Sujendran .S[1], Vanitha .P[2]

[1]Sri Muthukumaran Institute of Technology, Embedded System Technologies,
Chikkarapuram, Near Mangadu, Chennai-69, India

Abstract: ***The present technology commonly used for trimming the grass is by using the manually handle device. In this project we have automated the machine for trimming the grass. The device consists of linear blade which is operated with the help of the motor the power supply for the motor is by using battery. The battery can be charge by using power supply and solar panel. In case of any obstacles in the path it is sensed by using an IR sensor. If there is any variation then the device using free direction sensor and find the new path to travel. The above feature is enabled so that the damage to the hardware of the device is avoided. In future the automation of the device will play a vital role in world wide.***

Keywords: Infrared, Hand vibration, Noise levels, Solar panel.

1. Introduction

The first lawn mower was invented in 1830 by Edwin Beard Budding. He was said to obtain the idea after watching a machine in a local cloth mill which used a cutting cylinder mounted on a bench to trim clothes for a smooth finish after weaving. Budding realized that a similar concept could be used to cut grass if the mechanism is mounted in a wheel frame to enable the blades rotate close to the lawns surface. These early machines were made of cast iron and featured a large rear roller with a cutting cylinder (reel) in the front. Cast iron gear wheel transmitted power from the rear roller to the cutting cylinder. In 1832, Ransoms of Ipswich (under license) began the making of Budding's mower. This company is today the world's largest manufacturer of lawn care equipment. By mid-1850, Thomas Green developed a mower which used chains to transmit power from the rear roller to the cutting cylinder. It was called 'SilensMessor' meaning silent cutter. The machines were found comparatively lighter and quieter than the gear driven machines that preceded them. By late 1890, motorized mowers appeared as light weight petrol engines and small steam power units became available. In US, Colonel Edwin George produced the first gasoline powered mower in 1919. Electric powered mowers and rotary cutting machines emerged in the 1920's and 1930's. By 1960 the introduction of plastic components greatly reduced cost. Machines for grass cutting are widely used by workers in agriculture, gardening, landscaping, grounds keeping as well as by public. The main health hazards while maintaining the lawn using gasoline powered machines are noise and vibration. Both may impair human health irreversibly. Occupational health and safety requirements exist for workplaces affected by noise and vibration, but for public users there is no legislation concerning the potential health hazards for local vibration. The lawn-maintenance industry grows in suburban areas; it has become a new and significant source of environmental noise and occupational noise exposure. Most lawn maintenance workers spend from 8–10 h per day exposed to A-weighted sound levels greater than 85 dB, and it appears that few employees wear hearing protection. Sound levels were measured and monitored at the operator's ear and measured at a distance of 10 ft from the following equipment: lawn mowers, gas and electric edges, gas and electric trimmers, electric lowers, and electric hedge trimmer. A-weighted sound levels at the operator's ear ranged from 82 to 102 dB (Lesley et al., 1994).The aim of the study was to connect the local vibration hazard, the health damages and preventive measures. Additionally, frequency analysis of noise was conducted. Three types of agriculture machine were investigated: all-terrain vehicles (ATV), simple lawn-mowers (gasoline-powered push mowers), ride-on mowers (tractor type).Today, new technology has brought new improved versions. Low emission gasoline engines with catalytic converters are introduced to help reduce air pollution. Improved muffling devices are also incorporated to reduce noise. Today, the recent innovation is the rotary hover mower. There are primarily two types of mowers namely (i) the reel mowers, and (ii) the rotary mowers. The reel (cylindrical) mowers seem to be better. Made of blades on a revolving cylinder, they achieve clean cut by scissors action. As the mower moves forward, the rotating blades come in contact with a stationary bar called the bed knife and placed parallel to the ground. Grass is held by the shearing action of the reel blades against the bed knife. The mower is adjusted to various cutting heights. Rotary mowers are often powered either by an internal combustion engine or an electric motor and are generally moved manually, with the engine only spinning the cutting blades. The most common types are fitted with wheels, but a newer innovation is the hover model in which the spinning blade also acts as a fan that provides a lift force, lifting the mower body clear of the ground on the same principle with a hover craft. Rotary mowers generally have opening by the side of the housing through which cut grasses are expelled. Some are attached with a grass collector at the exit point. The blade is seldom sharp enough to give a neat cutting. The blade simply tears the grass resulting in brown tips. However, the horizontal blades are easy to remove and sharpen or replace. Existing engine trimmers suffer from high initial cost, high levels of engine noise, high fuel consumption rates and high operator's fatigue in long-run.[1] Studied noise control issues in the device carrying cutting blades.[2]Studied was to compare vibration and noise characteristics caused by different types of lawn maintenance machines in association with the risk factors to workers' health.[3] This machine was designed for the demands for a simple harvesting machine that cost less than IDR5 million/unit and power of 2 HP/6,000 rpm, with pure premium fuel or mixed gasoline.[4] Design for cost and operation ease.[5] Design and manufacture of the commercial grass cutting and collecting machine.[6] Studied Two-stroke single-cylinder internal combustion engines with small displacement volume belong to a group of driving units which are characterized by considerably noisy operation. These engines, owing to small sizes, small weight and the convenience of their use, are applied in devices such as grass trimmers, brush cutters or chainsaws for cutting wood. [7] The design objective is to come up with a mower that is portable, durable, easy to operate and maintain. It also aims to design a self-powered mower of electrical source; a cordless electric lawn mower. [8] Designed to increase the probability of system success, reduce risk and the total life-cycle cost. [9] Design and implement a Behaviour-Based Lawn Mower Robot controller that can be used to mow grass from lawns and play grounds autonomously. [10] Design for Remote and autonomous operation of robotic platforms is revolutionizing the way in which work is done and information is gathered. Through the removal of the human element, costs decrease, quality of work increases, and continuous operation is achievable at little to no additional cost. Remote control offers almost all individuals regardless of physical limitations the ability to operate machinery and perform labour intensive tasks at a safe distance. In this paper, an optimal mowing path planner including minimal time, minimal energy consumption, and minimal time/energy modes as well as a particular solution of complete coverage path planning (CCPP) is developed. Especially, incorporating the three modes enhances user convenience and reduces mowing cost in time and energy. The complete task of lawn mowing plan consists of two stages. The first stage is for the rough mowing path planning which considers the factor of working time or energy consumption. The second stage considers avoidance of static and dynamic obstacles. It modifies the details of the mowing paths by introducing a geography method, in which the idea of potential field is incorporated for obstacle avoidance. Applicability of the proposed design is verified via real-world experiments.

2. Path Planning Algorithm

A method is first proposed to determine three kinds of mowing paths in minimum time, minimum energy, and mixed operation to achieve the best efficiency. The minimal time mode means that the time consumed for cutting the whole lawn is minimal. The minimal energy mode means that the whole energy consumed during the period of mowing is minimal. The mixed mowing mode simultaneously considers time saving and energy consumption for lawn mowing to achieve a best compromise between two modes. To proceed, a variable *k* is introduced, which is defined as the number of the turning operation with the change of veering angle of the steering direction being ±180° ,For example, the number of *k* in Fig. 1

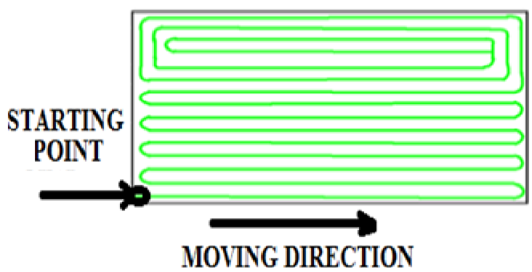


Figure 1: path planning

Next, an index of cutting difficulty is defined in the follows which represents virtually the moving distance:

Difficulty=

$$(Bw\ Dw-1)d+\pi(Dw-1)\frac{d}{2}+\left[\left(\frac{\pi}{2}-1\right)k+\left(\frac{\pi}{4}-1\right)(2Dw-2k-2)\right]d$$

(1)

Where,

$Bw=\frac{L1}{d}-1$ with L1 being the length of the working area,

$Dw=\frac{Lw}{d}$ 1 with Lwbeing the width of the working area,

$d = 10800\pi\ R_{earth}$(m/mmin) with R_{earth} (Km) being the radius of the Earth, and

$\frac{\pi}{2}-1$= the distance difference for a turning operation with the turning able being π

$\frac{\pi}{4}-1$= the distance difference for a turning operation with the turning able being $\frac{\pi}{2}$

(BwDw-1) d= total distance for the Straight navigation

$\pi(Dw-1)\frac{d}{2}$ =total distance for the turning navigation

$\left[\left(\frac{\pi}{2}-1\right)k+\left(\frac{\pi}{4}-1\right)(2Dw-2k-2)\right]$ d= total distance difference induced in the period of turning operation

Technically, the cutting difficulty in the form of (1) means the more distance the mower walks, the more difficulty the mowing job is. It is reasonable to assume that the mowing power is proportional to the difficulty to mow the same area with the same efficiency. Thus, one may let the ratio between mowing difficulty and mowing power to be *P* , and the index for power consumption of the mower be

$$P=P_o\left[(BwDw-1)d+\pi(Dw-1)\frac{d}{2}-\left(2-\frac{\pi}{2}\right)Dwd+\pi d+kd\right]$$

(2)

Where, $k \in [1, Dw-1]$.

3. Description

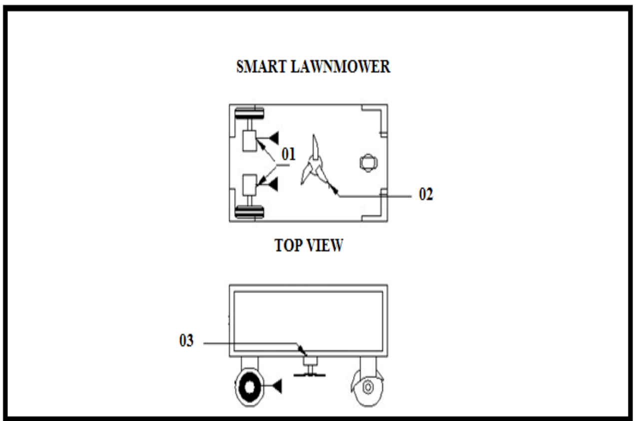
The lawn mower is made up of an induction motor, a battery, an alternator, three collapsible blades, and a link mechanism. The power and charging system comprises of an alternator which charges the battery while in operation. The D.C. motor forms the heart of the machine and provides the driving force 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 an electrical switch which completes the circuit comprising the induction motor and the battery. The IR senor is finding the path to avoid the obstacles and machine damage. The shaft fitting mechanism with which the height of cut is altered.

3.1 Components list

Table 1: Components list for mower

S/N	*ITEM*	*QTY*	*REMARK*
1	DC motor	2	Rotating the wheel
2	DC motor	1	Rotating the blade
3	Wheel	3	Mowing the mower
4	Battery	1	Power supply for motors
5	Solar panel	1	Power supply for batteries
6	IR sensor	1	Obstacle detection
7	Collapsible blade	3	High carbon steel resist wear

3.2 Design Concept



S.NO	PART NAME	SYMBOL	POWER SOURCE
01	DC MOTOR	▶—	FROM BATTERY
02	BLADE		
03	MOTOR	▶—	FROM BATTERY

Figure 2: Orthographic view of the mower

3.3 Operation principle

Electrical energy of the battery is converted to mechanical energy through a set of blades designed to achieve cutting operation. The electric circuit ensures power transfer from the battery to run the D.C. motor, whilst the solar panel power to continuously recharge the battery while in operation. The cutting blades tap power from the D.C. motor. When the power switch is on, the electrical energy from the battery powers the motor which in turn actuates the blades. The solar panel generates current to recharge the battery, thereby compensating for the battery discharge. The rotating blades continuously cut the grass as the mower is propelled forward and the cut grass. Height of cut is adjusted by means of the link mechanism via the lift rod.

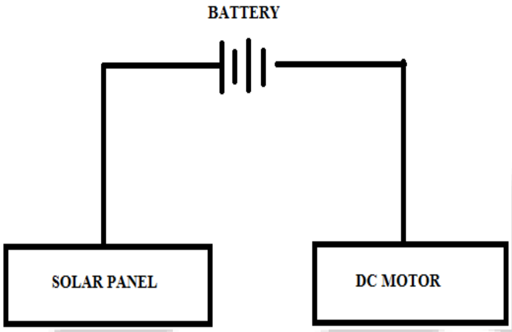


Figure 3: Circuit diagram of the mower

4. Design Analysis

The shearing force of most annual and perennial grasses found on most lawns is usually between 9.2N ~ 11.51N (Yong and Chow, 1991).

Force required by cutting blade to shear the grass is given by;

F =T/R (1) (Khurmi, 2003, Basil Okafor2013)

Where T = Shaft torque;

R = Radius of cutting blade

But shaft torque is given by;

T = P/2πN (2) (Khurmi, 2003, Basil Okafor2013)

Where P = Power developed by shaft;

T = Torque required; and N = Shaft speed in Rev/min

4.1 Selection of electric motor:

4.1.1 30 RPM DC motor

SPEED = 30 RPM
VOLTAGE = 12 VOLT
WATTS = 18 WATT

4.1.2 Torque of the motor:

Torque = (P X 60) / (2 X 3.14 X N)
Torque = (18X 60) / (2 X 3.14 X 30)
Torque = 5.72 Nm
Torque = 5.72 x 10^3 Nmm
The shaft is made of MS and its allowable shear stress = 42 MPa
Torque = 3.14 x fs x d ^{3} / 16
5.72 x 10^3 = 3.14 x 42 x d ^{3} / 16
D = 8.85 mm
The nearest standard size is d = 9 mm.

4.1.3 Electrical (electric) power equation:

Power $P = I \times V$
Where
V = 12
W = 18
I=18/12=1.5 A
H.P = .02414

4.1.4 Solar panel calculation:

VOLT = 12 V
WATT = 5 W
W = V X I
5 = 12 X I
I = 5/12
I = 420ma

4.1.5 Battery calculation:

B_{AH} /C_I = 8 ah/420ma = 19 hrs
To find the Current
Watt = 18 w
Volt = 12v
Current =?
P= V x I
18 =12 x I
I = 18/12 = 1.5 AMPS
BATTERY USAGE WITH 1.5 AMPS
B_{AH} /I
8/1.5 = 5.3 hrs.

5. IR Sensor Circuit

Infrared transmitter is one type of LED which emits infrared rays generally called as IR Transmitter. Similarly IR Receiver is used to receive the IR rays transmitted by the IR transmitter. One important point is both IR transmitter and receiver should be placed straight line to each other. The transmitted signal is given to IR transmitter whenever the signal is high, the IR transmitter LED is conducting it passes the IR rays to the receiver. The IR receiver is connected with comparator. The comparator is constructed with LM 358 operational amplifier. In the comparator circuit the reference voltage is given to inverting input terminal. The non-inverting input terminal is connected IR receiver. When interrupt the IR rays between the IR transmitter and receiver, the IR receiver is not conducting. So the comparator non inverting input terminal voltage is higher than inverting input. Now the comparator output is in the range of +5V. This voltage is given to microcontroller or PC and led so led will glow.

When IR transmitter passes the rays to receiver, the IR receiver is conducting due to that non inverting input voltage is lower than inverting input. Now the comparator output is GND. So the output is given to microcontroller or PC. This circuit is mainly used to for counting application, intruder detector etc.

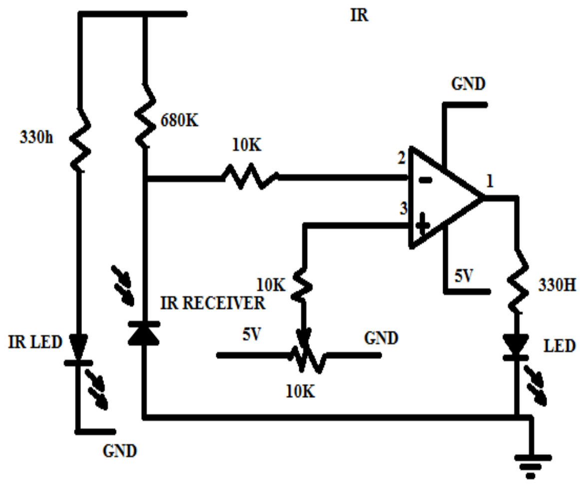


Figure 4: IR circuit

6. Designed Wheeled Mower

Figure 5: The Experimental Wheeled Mower

5.1 Mower noise

Existing engine trimmers suffers from high levels of engine noise. Average noise level during operation with nylon thread was found 78dB with the available engine silencer. An additional muffler was designed in this study to absorb output noise conveniently by creating a small back pressure without appreciable reduction in output power. A noise level of 5 -7 dB was reduced with added muffler unit. A noise level of Smart lawnmower is 2dB was reduced by using DC motor.

7. Design Flow

Step 1- Initialize the starting point of the mower
Step 2- Move forward direction after start the mower
Step 3-IF obstacles can be detect mower move left and move forward ELSE move forward
Step 4- IF area length is finish turn two left ELSE move forward.

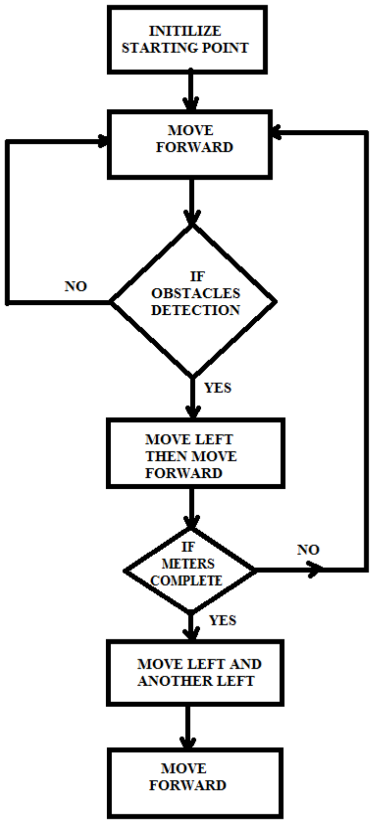


Figure 6: Flow chart for the mower

8. Conclusion

The smart lawnmower design is achieved minimum working time, minimize the cost, minimum energy consumption, and mixed operation mode. The theory proposed in path planning has been verified with experiments. In future a grass collection box can be mounted.

References

[1] P.Bulski, S.D Yu &Davidge E D, Investigation of sound induced by grass cutting blades, J EnggApplSci, 3 (2008)290-298.
[2] P. Tint & G. Tarmas, T. Koppel, K. Reinhold and S. Kalle, Vibration and noise caused by lawn maintenance machines in association with risk to health,Agronomy ResearchBiosystem Engineering Special Issue 1(2012) 251-260.
[3] Handaka&JokoPitoyo, Modification of a grass cutter into a small rice harvester, Indonesian Journal of Agriculture 4(1), (2011) 40-45.
[4] R. K. Mandloi, Rajesh Gupta & A. Rehman, Design, Development and Testing of Low Capital andOperational Cost Shrub Cutting Machine,Journal of Rangeland Science, (2011) Vol. 1, No. 2.Planning has been verified with experiments. In future a grass collection box can be mounted.
[5] AaqibGulzar Khan &Adeel-ul-HaqQurishi, Commercial Grass Cutting cum Collecting Machine, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 10, Issue 1 (Nov. - Dec. 2013), PP 35-38.

[6] Tomasz Figlus, Andrzej Wilk&PatrykFranke, The Estimation of Changes in The Noise Level Generated by Devices Equipped with Two-Stroke Internal Combustion Engines with Small Displacement Volume, FME Transactions (2013) 41, 216-221
[7] Basil Okafor, Simple Design of Self-Powered Lawn Mower, International Journal of Engineering and Technology Volume 3 No. 10, October, 2013.
[8] Guoping Wang, and Zhuming Bi, Incorporating Systems Engineering Into The Senior Design – Autonomous Lawn Mowing Machine,American Society for Engineering Education March 17, 2012
[9] Muhammad Wasif, Design and Implementation of Autonomous Lawn- Mower Robot Controller, IEEE978-1-4577-0768(2011)
[10] Kevin LaMott&SabriTosunoglu, Development of a Robotic Lawnmower as an Adaptable Platform for Swappable Remote and Autonomous Control Packages, Florida Conference on Recent Advances in Robotics, FCRAR 2010 - Jacksonville, Florida, May 20-21, 2010.

Author Profile

Sujendran.S completed diploma in Computer Engineering from Pallavan polytechnic college in 2008 and B.E degree in Instrumentation and Control Engineering from Dr. Mahalingam College of Engineering and Technology in 2012, now studying M.E in Embedded System Technologies from Sri Muthukumaran Institute of Technologies in 2012-2014.

Vanitha.P completed B.E degree in Electrical and Electronics Engineering from Odaiyappa College of Engineering and Technology in 2006 and M.E degree in Power Electronic and Drives from Sona college of Technology2008 .Worked at NPR College of Engineering and Technology from Jan 2009 to May 2009, and Kurinji college of Engineering and Technology from June 2009 to June 2010, working at Sri Muthukumaran Institute of Technology from July 2010 onwards